THE

AMERICAN NATURALIST.

ADAPTATIONS TO AQUATIC, ARBOREAL, FOS-SORIAL AND CURSORIAL HABITS IN MAMMALS.

II.   ARBOREAL ADAPTATIONS.

LOUIS I. DUBLIN.

IN THE struggle for existence it is apparent that single forms and whole groups of forms would independently become modified to a life off the ground.   Very often only by such an adaptation could small defenseless animals save themselves from the attacks of larger and speedier carnivores.   In addition, there is the question of food.   The larger animals to whom the bulk of terrestrial food naturally goes are virtually absent from the trees. We accordingly find a multitude of animals that have made this region their abode where, freed from their enemies and with an abundance of food they have prospered.

PARTIAL LIST OF ARBOREAL MAMMALS.

Order MARSUPIALIA.

Family Didelphyidæ (all except Chironectes).
  "   Phalangeridæ
  "   Macropodidæ (Dendrolagus only).
  "   Dasyuridæ (Dasyurus and Phascologale only).

Order Edentata.

Family Bradypodidæ, Myrmecophagidæ (only Tamandua and Cycloturus).

Order Ungulata.

Sub-order Hyracoidea (Dendrohyrax).

Order Carnivora.

Family Felidæ (many partly, the Jaguar alone truly arboreal).
    "   Viverridæ (the Fossa, Viverra and Arctictis).
    "   Procyonidæ (Procyon, Kinkajou, Bassariscus, Nasua and Bassaricyon).
Family Mustelidæ (the Martens and Helectis).
Family Ursidæ (the Brown Bear).

Order Rodentia.

Family Anomaluridæ.
    "   Sciuridæ (Sciurius).
    "   Lophiomyidæ.
    "   Myoxidæ.
    "   Hystricidæ (only the American sub-family Synetherinæ).

Order Insectivora.

Family Tupaiidæ.
    "   Erinaceidæ (Gymnura only).
    "   Galeopithecidæ.

Order Cheiroptera.

Order Primates.

(All except Homo and the Baboons.)

It will be observed from this list that with the exception of the Monotremata, the Cetacea and the Sirenia all the mammalian orders have arboreal representatives. Thus of the six

existing marsupial families two are completely arboreal while arboreal forms are found in one or more representatives of each of the remaining families. Among those forms that are not arboreal there still persists a considerable number of vestigial structures and conditions in the pes all pointing unmistakably to a previous arboreal life. In like manner among the edentate sloths, many of the smaller Carnivora, Rodentia and Insectivora and finally the Cheiroptera and in large part the primates have become arboreal.

This adaptation however is probably a secondary one, acquired independently by the different orders. We should therefore expect diverse forms of the adaptation to exist. Here we shall distinguish the following main types :

I. *Partially arboreal.* These are still capable of terrestrial life. Here belong the majority of the carnivores, insectivores, and rodents, and Dendrohyrax.

II. *Strictly arboreal.* This contains the remaining forms and is divisible into three sub-groups.

(a) Modified for running on branches.—Arboreal marsupials and lemurs.

(b) Modified for suspension from branches.—Sloths and bats.

(c) Modified for swinging by fore limbs ; hind limbs on the marsupial type.— Remaining arboreal primates.

It is clear that this classification expresses corresponding differences in foot structure. In the first group the pes is little different from the typical terrestrial running foot. The phalanges have, as in the raccoons, become much elongated and the soles are often naked. In some cases a distinct plantigrady has replaced the previous digitigrady.

It is in the second group that the greatest modification has occurred. In the first subdivision (a) the foot has become an almost perfect grasping organ ; the hallux being opposable ; the second and third digits have reduced and united ; the fourth toe is greatly elongated. There is also a distinct regression of the claws ; for as the foot becomes more and more prehensile in structure the nail is no longer indispensable and is lost (Dollo).

In the second sub-division (b) of the second group, the manus and pes have become much elongated and centrally strengthened

and the nails have been modified into hooks by means of which the body is kept in suspension. The number of digits is reduced to two in Cholœpus and three in Bradypus. The carpal and tarsal elements are laterally compressed and there is some anastomosis. This forms a more compact centre of resistance while the proximal bones develop a more or less complete ball and socket joint in connection with the distal ends of the radius and tibia, to permit a more perfect rotation.

In the last sub-division (c) both the manus and pes have become grasping organs. The hallux or pollex, or both, are generally opposable. Many modifications occur in the pes very similar to those already described for the marsupials.

But in spite of these differences in main type there are developed certain important characters which distinguish arboreal forms as a group from related terrestrial and aquatic types. These like responses to the same conditions are to be observed in what are otherwise most diverse forms. These characters are the following :

1. The tail is often prehensile and, as in some of the Cebidæ, naked at the tip being a sort of fifth arm with which the animal can move from branch to branch. Frequently correlated with this adaptation is the loss of the thumb.

2. Ectodermal spines are often developed. These may occur on the root of the tail as in the Anomaluridæ, on the shoulder or on the feet as in Gymnura and some of the Anthropoidea. In all these cases the spines are climbing organs.

3. The limbs are much elongated. This elongation may occur in different segments in different forms. In the swinging apes, it is the fore-arm rather than the hand which is elongated. In the tree-sloths all the limb segments except the compressed carpalia and tarsalia and proximal phalanges are lengthened, the very long remaining phalanges and the claws forming a hook for suspension. In other forms the tarsals are greatly lengthened as in Tarsius, Galago and other lemurs. These elongations are obviously connected with the climbing and leaping habits of these forms.

4. The hallux or pollex, or both, are generally opposable. This gives the hand or foot a stronger hold on the branches and

is perhaps the most important element in the arboreal limb. It disappears however when the animal moves in suspension as in the sloths.

5. The clavicle and scapula are well developed. These give strength to the fore extremities and thus increase the climbing power. It is interesting to observe that, as occurs in the Hystricidæ, the clavicles will be developed in one arboreal form while a terrestrial member of the same family will have vestigial clavicles or none at all. Together these two bones strengthen the pectoral arch "in the transverse direction; that is, against lateral strains of pulling and pushing, which came almost entirely from the use of the anterior limbs (Cope)."

6. The ilium is broadened in some forms, particularly in Anthropoidea and the tree sloths. This adaptation is for the support of the viscera. In the edentates the pubis is directed posteriorly.

7. In arboreal forms the ribs and chest are powerfully developed as compared with the conditions in their non-arboreal relatives.

8. The number of the dorsolumbar vertebræ is often increased. It is in the tree sloths among the Edentata that the greatest elongation occurs. In the two-toed Cholœpus the number is twenty-seven, and twenty-five in the species *didactylus* and *hoffmanni* respectively, while the number typical for the other forms of the order is about nineteen. In the three-toed Bradypus the number is the typical nineteen. Curiously enough it is the cervical region which is here elongated there being nine cervical vertebræ instead of six or seven as in the remaining Edentata. While one form has specialized itself to firm suspension the other has more or less sacrificed this character for a perhaps more valuable one — the mobile neck. Among the Rodentia where the typical number of dorsolumbars is nineteen, Capromys which is arboreal possesses twenty-three. Hyrax and Dendrohyrax have thirty and twenty-eight respectively ; fully six more than that prevailing among the terrestrial ungulates.

If inverse evidence can be of any value, it is known that in the human species, ancestrally adapted to arboreal life, there is a tendency toward the shortening of the back ; there being gen-

erally, one less vertebra in man than in the still arboreal apes. On the other hand among the marsupials where typically arboreal forms prevail the number is constant for the group — nineteen. This may be due to the fact as Dollo has shown that the terrestrial forms have but very lately modified themselves to this mode of life — the whole group of marsupials having been at one time arboreal. In like manner the number in the carnivores is constant (twenty). In this group the arboreal forms have but lately diverged from their terrestrial relatives. In the Insectivora there is also no difference of any significance.

Among isolated adaptations may be mentioned the modified feet of Hyrax and Dendrohyrax. As described by Dobson these animals are enabled to climb perpendicular walls and trees without the use of claws ; nor is there an opposable hallux or pollex. The thickly padded tuberculated soles are drawn up by certain flexor muscles thus leaving a vacuum by means of which the animal retains its hold. In the Cercolabidæ there are in addition to other arboreal characters such as spines, tubercles on the soles which may serve as in Hyrax.

BIBLIOGRAPHY.

ALLEN, H.
'**93**. A Monograph of the Bats of North America. Bull. U. S. Natl. Mus. No. 43.
BEDDARD, F. E.
:**02**. Mammalia. Cambridge Nat. Hist. Vol. 10.
COPE, E. D.
'**89**. The Mechanical Causes of the Development of the Hard Parts in the Mammalia. Journ. Morph., Vol. 3.
DOBSON, G. E.
'**76**. On Peculiar Structures in the Feet of Certain Species of Mammals which enable them to walk on Smooth Perpendicular Surfaces. Proc. Zool. Soc. 1876. London.
DOLLO, L.
'**98**. Les ancêres des Marsupiaux étaient-ils arboricoles? Trav. Stat. Zool. Wimereux, Tom. 7.
FLOWER, W. H. and LYDEKKER, R.
'**91**. An Introduction to the Study of the Mammals Living and Extinct.
MUYBRIDGE, E.
'**77**. Animal Locomotion.

MUTATION IN PLANTS.[1]

D. T. MACDOUGAL.

It is presumably safe to say that all students of natural history agree in the opinion that living matter has qualities at the present time that it did not originally, or always possess, and furthermore it is universally conceded that protoplasm is undergoing such development that it is constantly acquiring new properties, and taking form in an increasing number of types, kinds, or species of organisms as a consequence. In other words living matter is increasing the number of its qualities, multiplying the number of forms in which these qualities are variously grouped, and at the same time undergoing such differentiation that an increasing complexity is the general tendency of the organic world. These facts once realized the biologist finds himself confronted with two stupendous interrogatories. By what method is the general development and differentiation of organisms brought about as expressed in the formation or origin of new species, and secondly what are the general factors which shape this progression? The amount of mere discussion ensuing from the presentation of conflicting views brought out by these questions, in comparison with the total scientific effort to obtain positive evidence upon the points involved is appalling to contemplate. Happily the biological world is becoming intolerant of wrangling and speculative contentions, and has earnestly set about finding the facts that will afford an adequate and satisfactory solution to the main problems. The cult of the study of statistical variations may be regarded as one expression of this newly assumed attitude, while the devious, intricate and oft-times labyrinthine ways of cytological investi-

[1] The general discussion of the mutation theory embodied in this paper, together with an exhibition of the seedlings of Œnothera was given before the Zoological Seminar of Columbia University, April 23, 1903. The comparisons between the mutants were not completed until August, 1903.

gations have, or should have, their chief purpose in the discovery of the physical mechanism of heredity.

The terms *discontinuous variation*, or *mutation* in connection with the study of inheritance, descent, and the origin of species may be taken to mean the autonomous physiological processes by which one or more individuals of a species give rise to off-spring which exhibit qualities, or groupings of qualities not pos-sessed by their immediate ancestors and not previously exhibited by the individuals comprised in the parent species (progressive mutation), or by which one or more individuals give rise to indi-viduals lacking qualities or groupings of qualities exhibited by the ancestral forms (retrogressive and degressive mutation). These aberrant individuals or mutants may transmit their char-acters to their offspring in such a manner as to give rise to a new line of descent constituting the origin of a new type by mutation.

The number of freaks, sports, bud-variations, and specimens of plants with abnormal forms and sizes of leaves, stems, and flowers, some of them highly teratological, to which attention has been called by various writers in botanical periodicals under the designation of mutants makes necessary the emphasis of the fact that observations on a single individual, or a single gen-eration of individuals are of but little value in distinguishing fluctuating variations from mutations. Results worth a moment's consideration may be obtained only by the most careful exclusion of the possible effects of disease, of animal or plant parasites, of hybridization, and by a careful analysis of the phylogenetic value of the divergences as tested by observations on successive generations of living forms. It is in this manner, and in this manner alone, that discontinuous, saltatory variations may be distinguished from the results of common, fluctuating and indi-vidual variability. Mutation rests in the main upon such sub-stantive, discontinuous variations as the acquisition of new characters, or the loss of old ones hitherto transmitted by the parent type, or upon simultaneous alterations of both kinds. These changes may be accompanied by, or may result in, the masking of current qualities, or the unmasking and energizing of latent qualities of the parent type.

The essential differences between the two processes appear to have been originally set forth by Charles Darwin,[1] and are treated at length by deVries.   The formal distinctions drawn by deVries appear to need some slight modification and elaboration in order to make them universally applicable.   Thus he holds that continuous, or fluctuating variability occurs only in accordance with Quetelet's laws, and that it involves only the number, size and weight of organs, and does not include differences in qualities. Cultural experiments of various kinds during the last few years have given results in which the qualities as well as the number, size and structure of organs have been materially altered, but such induced variations or divergences were not transmissible. This particular factor in distinguishing between fluctuating and mutating variability therefore becomes a safe one, when it is modified to make mutating variability include only newly acquired and transmissible qualities.   The presence of a plant or an animal parasite may not only change the mechanical features of an organ but may also cause most radical alterations in its physiological properties.   A single example of the latter may be cited in the case of the common species of Euphorbia in which the affected leaves alter their geotropic sensibility in such manner that they change from diageotropism to apogeotropism. Such variations are not transmissible however, and in this lies the true test between mutation and fluctuating variation.   A still further distinction consists in the fact that mutations ensue in the rudimentary state of the individual, while the alterations in qualities induced by any of the above factors in fluctuating variability may be caused in various stages of the development of the individual, but in a rudimentary stage of the organs concerned.   Mutative alterations arise with the individual, are not the direct result of external factors, and are perfectly transmissible, while fluctuating variations may arise by the influence of external factors at various stages in the individual development, and are not transmissible in their entirety.

Much of the confusion inevitable to any discussion of the subject may be avoided if it is borne in mind that we habitually

[1] DeVries. *Mutationstheorie*, Bd., 2, 1903.

deal with two different conceptions under the term species, one based upon systematic and the other upon physiological, or sexual affinities. The last named conception considers species as phylogenetic groups embodying certain elementary characters and showing certain capacities and habits, some of which may not find expression in external form and structure. The systematic conception of species runs closely parallel to the above and should finally express the actual blood relationship of all of the forms in the vegetable kingdom. It is practically impossible however, to take into account features not actually expressed in some definite measurable structure, or which may not be determined by some rigid physical standard, and comply with taxonomic methods. Thus numerous undoubted instances are known of two or more groups of forms embodying separate lines of descent, which, however, may not be separable by taxonomic standards. The present discussion is of course concerned only with the physiological conception of species, although as may be seen by an examination of the features of the mutant forms brought under consideration, these present anatomical characteristics sufficient to warrant their recognition upon any taxonomic basis.

The special purpose of the present paper is to consider discontinuous variation as a probable method of the origin of new species, and to present the results of two season's observations on the form, habit and behavior of some of the mutant forms discovered by deVries seventeen years ago.

The observation and recording of marked examples of discontinuous variation in lines of descent is as old as biological science itself. Recently this procedure has been brought into the focus of attention anew as the result of the deVries investigations, which tend to demonstrate that it is an important means by which species come into existence. More than three centuries ago (1690), Sprenger the apothecary of Heidelberg, who had *Chelidonium majus* under cultivation, noted the sudden appearance of a type with laciniate leaves in his garden. This form which is also distinguished by other characteristics, was found to be constant and self-maintenant in competition with the parent type, and has remained distinct to the present day with-

out artificial selection, and no specimens have ever been seen which could not be traced back to this original lot of individuals in Heidelberg. The citation of a large number of equally well or better authenticated instances of the sudden origin of types is to be found in Korschinsky's memoir to which reference is made below.

The space at command does not permit even an outline of an historical sketch of the views of the more prominent writers on descent, concerning discontinuous variation as a means of origin of species. It may be said, however, that Darwin attributed some importance to "single variations" in his earlier writings but seemed to relinquish this favorable view of the matter under the pressure of criticism to which he was subjected in connection with all phases of his opinions on the origin of species. Kölliker's theory as to the transmutability of egg elements as a means of heterogenesis in 1864 will be recalled in this connection.

Dollo is credited by deVries with being the first to announce definitely the conclusion that species might originate by mutation (1893) (*Mutationstheorie*, Bd. 1 : p. 46). Bateson goes so far as to say in his summary of *The Material for the Study of Discontinuous Variation* (1894) that "It (The evidence of variation) suggests in brief *that the discontinuity of species results from the discontinuity of variation.*

Korschinsky (1899) published a most valuable historical account of the better authenticated instances of types supposedly originating by discontinuous variation, and made a comparison of the theories of natural selection and heterogenesis. The German reprint of his paper (*Flora*, 89, pp. 240–363, 1901) is the completest yet published in citation of facts and in review of pertinent literature, and it forms a logical historical prelude to the observations of deVries.

The first well-guarded scientific observations of the origin of new types as a result of discontinuous variation were made by deVries, who by the expenditure of a great amount of labor carried out an extensive series of experiments in the cultivation of plants of the old *Œnothera lamarckiana* type. The general facts obtained by him have been brought to notice repeatedly

within the last three years and it will not be profitable to rehearse the details at this time. Briefly stated deVries's investigations may be embodied in the following paragraphs.

1. Observations were chiefly concerned with a large number of plants growing wild and under cultivation, of the type of *Œnothera lamarckiana*. The identity of the parent form was found by comparison with the original description of the plant made a century earlier, and by comparison with a type specimen in the Muséum d'Histoire Naturelle in Paris collected in 1788. The actual name of this plant in the revised nomenclature is a matter of minor importance in the present connection.

2. Numbers of individuals of the parent type, as a result of cross- and self-pollination indifferently, constructed seeds which developed into independent forms, constant and self-maintenant, which differed in habit, structure, stature, appearance and properties from the parent type.

3. The aberrant or mutant forms might be divided by characters as sharp and numerous as most of the so-called minor species of the systematist.

4. No forms intermediate between the mutants, or between the mutants and the parent type were found.

5. That the mutant forms were really groups of phylogenetic value was proven by their behavior when crossed with one another, with the parent form, and with other species in the same genus. The hybridization experiments with these forms has yielded some exact evidence as to the preponderance of phylogenetically older characters by reason of the fact that the mutants are forms the exact ages of which are known. Of the crosses of *Œ. lata* and *Œ. nanella* with the parent form, from a half to three-fourths were found to be of the parent type, and the remainder of the mutant type form. The crossing of mutants with each other produces a generation many of which show reversionary characters. The mutation hybrids are constant in succeeding generations. The separation of antagonistic characters in the first generations is weighty evidence in support of the theory of elementary characters, and for the mutation theory.

6. The new types were either constant from the beginning, or if weak, inconstant or perishing, showed no tendency to revert

to the parent type, and their constancy or fixity might not be increased by artificial selection.

7. More than one mutant might arise simultaneously from the parent individuals.

8. Any one of the several mutants observed might originate from several parent individuals simultaneously.

9. The mutant forms might arise from successive generations of the parent types.

10. The mutant forms might in turn give rise to new types after their separation from the parent type.

The above statements rest directly upon observations of carefully conducted experimental cultures and admit of but little argument as to interpretation. With this positive evidence at hand questions at once arise as to the frequency, occurrence, prevalence, exclusiveness, and as to the mechanism of discontinuous variation as a method of origin of new species. When we take up these points we at once enter a field of speculation in which it may be seen there is opportunity for unlimited argument, and in which with the bias to which most of us are subject as a result of our training and investigations, it is difficult to maintain a purely judicial attitude. It will be profitable to recall some of the more important facts bearing upon these matters however.

First, as to the occurrence of discontinuous variations in plants the following examples cited by Korschinsky will be illustrative : *Erythrina crista galli* was introduced into cultivation in 1771 and no aberrant forms were seen until seventy-three years later: *Begonia semperflorens* showed deviating forms only after fifty years : *Cyclamen persicum* gave no unusual forms until after one hundred and twenty years of observation : no mutations were observed in *Ipomoea purpurea* in one hundred and twenty years.

De Vries observed many thousands of individuals of a hundred species growing in the vicinity of Amsterdam in 1886 and 1887 and found mutations in only one, that one *Œnothera lamarckiana*. He points out that remains of plants of various species found in mummy cases four thousand years old have been found identical with living species in all recognizable characters. As a result of a rough examination he also concludes that the

elementary characters of any species of a higher plant may be reckoned at a few thousand — about 6000 in Œnothera. If Lord Kelvin's estimate of the period during which life has existed on the earth is accepted it might be concluded that in a general way the average interval separating mutable periods of any plant must be several thousand years, although nothing in the nature of the question may be taken to indicate anything like uniformity in the matter. Some writers have put forward the conclusion that at least ten times the above named period, or twenty-five hundred million years, would be necessary for the derivation of the existing forms of plants and animals by natural selection. It must be admitted that both ideas are valuable chiefly as attractive examples of imaginative grasp rather than as affording any real evidence in the matter.

It will be recalled that the various theories which have been put forward to account for the origin of species have been held by their authors and advocates to be mutually exclusive, and it seems to have been, and is still taken for granted by the majority of writers, that all organic forms, both plants and animals, have arisen in the main by one simple method of biological procedure. The development of biological science has certainly reached a stage where this a priori generalization may well be abandoned. I can not say that a candid review of the mechanism of protoplasm, or of the pertinent evidence, from any point of view compels adherence to this ancient assumption.

The great amount of critical study that is being directed to the study of hybrids and hybridization is widening the horizon of this subject momentarily, and the result of our recently acquired information leads us to conclude that species may originate by crossing. In such instances the new types are due either to new combinations of unit characters or to reversionary qualities, it being necessary to keep in mind the fact that by such union of two types no new characters are brought into existence. It must be regarded as unsafe moreover to declare any plant a hybrid of any other given forms unless the process of origin has been carefully followed. The fact remains that hybridization is a demonstrated source of origin of species however, and it is becoming more and more generally recognized that more than one method

of procedure may have been followed in the development of the prevalent types of vegetal organism. This view of the subject has been thoroughly discussed by von Wettstein and need not occupy our attention further at the present time (*Bericht, deut. Bot. Gesell.*, Bd. 13, p. 303, 1895).

DeVries concedes that species might originate by more than one method, but he holds that natural selection may account for neither the origin, nor the preservation and continuance of species. He furthermore calls attention to the fact that Darwin repeatedly asserted that characteristics or qualities were formed very slowly but might disappear suddenly, or in other words that retrogressive and digressive species formation might ensue by discontinuous variation or mutation. (*Mutationstheorie.* Bd. 2 : 661. 1903.)

It is necessary to point out that the use of the term *natural selection* as applying in any sense to the *origin* of species by mutation is wrong in view of the special meaning long attached to that phrase. Natural selection implies constant and progressive variation in one or many directions, the individuals distinguished by the greatest improvements constituting the fittest and surviving from successive generations. The constant and repeated survival of the fittest and most improved effecting in time such an amount of departure from the original as to constitute a new type. The mutants which arise in discontinuous variability are seen to depart in all directions from the original, but none of these may be fitter than the parent type and may perish. It is probable that many thousands of mutants come into existence for every one that is capable of existence in competition with the parent type. The repeated failure of the successive series of mutants can in nowise affect the character of the later crops of discontinuous derivatives, and hence the failure of the non-fit and the endurance of the improved form are not dependent upon natural selection. Every mutant that survives must not only be suitable for its environment but must be of a structure and habit that will enable it to compete successfully with existing types, in comparison with which it is enormously weaker in numerical strength. It must therefore gain a foothold at once, with but little opportunity for adaptations of any kind. Every mutant is

a possible species and the only selection which might be said to act is that which determines the type able to live : this selection has nothing to do with the origin of the surviving form however.

Thus of the sixteen mutants discovered by DeVries one had already established itself when found, although seen to arise anew from the parent type subsequently. Perhaps one or two of the others might have succeeded in gaining a foothold, but the majority of the new forms must have inevitably perished if subjected to the ordinary competition of the prevailing meadow species.

As to the cause of mutation, and the mechanism of the process but little except of a speculative nature may be offered. Korschinsky assumes that heredity and variability are opposing forces or tendencies which are ordinarily balanced. External agencies such as successive seasons of good nutrition might allow the tendency to variation to overcome the hereditary stability and allow the origination of a new form as a result of the unloosed, superfluous unbalanced energy. He supposes that whatever the agencies may be that cooperate to bring about the mutative condition, these forces act upon the developing embryo in the seed, although he hazards no guess at the manner in which this might be accomplished (*Flora*, 89 : 240, 1901). The above it may be noted is in direct contrast with the proposal of Darwin that the development of new types is more rapid when species are competing under adverse conditions, or when the struggle for existence is fiercest.

So far as DeVries's theory of mutation is concerned it may be said to be the logical outcome of, and to rest upon his hypothesis of intracellular pangenesis. By this, protoplasm is taken to consist of ideally minute pangens, which make up the living substance. The pangens and aggregations of pangens are the bearers of the elementary characters of the species. Alterations in the numerical relations of pangens are made to account for fluctuating variability. The inactivity of pangens and groups of these units would cause degressive or retrogressive mutation. The formation of new characters in progressive mutations would depend upon the development of new pangens, this process constituting premutation. The formation of identical pangens in separate species would account for parallel mutations.

But little definite evidence is at hand as to the time at which the changes antecedent to mutation, constituting pre-mutation occur, although certain stages of development may be designated, previously to which they must come about. Mutations of the higher plants are first apparent in the seedling but the actual alterations or departure from the hereditary behavior must have taken place at least as far back as the formation of the sexual elements the union of which produced the embryo, and may have occurred even earlier. In any case the mutants are perfectly formed in the embryo and influence of any kind upon the germinating seed may not alter their nature (see page 746). It may be seen from the foregoing that the mutative processes may be connected with either the vegetative body or the sexual elements, and may be found within the sporophyte, or be confined to the gametophyte.

If the pre-mutative alterations occur in the vegetative protoplasts of a self-fertilized individual both gametes would presumably carry the same characters to the union. If, on the other hand, premutation occur in one of the sexual elements, or if it occur in the vegetative cells of species which are cross fertilized only, the embryos formed would be the result of the union of one mutant gamete and one of the regular inherited form. In a sense such mutants might be considered as hybrids. This theoretical aspect of the question seems to find a reflection in the behavior of *Œ. lata*, one of the mutants with pistillate flowers only. When pollinated by the parent form, *Œ. lamarckiana*, it produces *Œ. lata* and *Œ. lamarckiana*.

DeVries conjectures that the causes inducing mutation are partly internal, and partly external to the organism. The state of external factors necessary to the process probably occur only at uncertain intervals, and is supposed to embrace a combination of extremely favorable and unfavorable conditions.

Probably no more profitable subject for research in the whole realm of natural history offers itself to the investigator than the problem of the causes which produce new species. The above supposition deserves early attention from the experimentalist since it is one that is comparatively easily capable of proof and disproof.
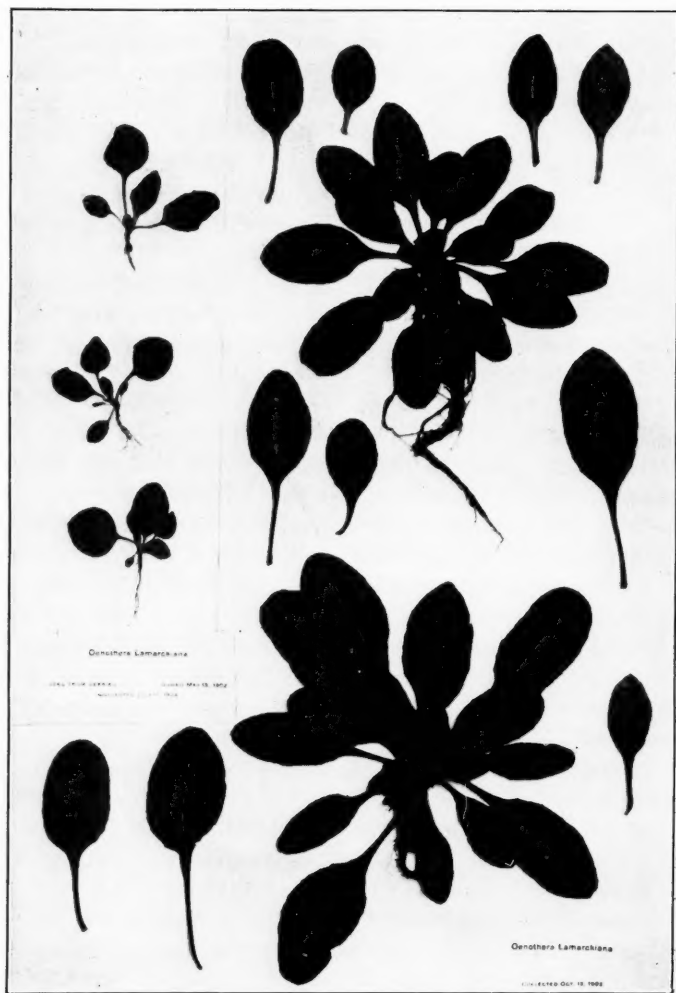
FIG. 1.—*Œnothera lamarckiana.* Rosettes of seedlings two months, and five months of age. Photographed from herbarium sheets. (See Figs. 2 and 3.)

Fig. 2. *Œnothera rubrinervis.* Seedlings two months, and five months of age. Photographed from herbarium sheets. (See Figs. 1 and 3.)

Being desirous of testing the general facts of mutation as illustrated by the behavior of the œnotheras under environmental conditions different from those at Amsterdam, seeds of *Œ. lamarckiana, Œ. rubrinervis, Œ. lata, Œ. nanella, Œ. brevistylis,* and *Œ. gigas* were procured from Professor DeVries and these were placed in soil in the propagating houses of the New York Botanical Garden May 15th, 1902. Germination followed in a few days, and a number of individuals ranging from fifteen to forty of every species were pricked out and suitably repotted from time to time. The cultures were examined three to seven times per week except during February, 1902, and July, 1903. The amount of work necessary to make minute and exact observations on all of the above forms being too great a demand upon my time, chief attention was devoted to a comparison of the parent type with *rubrinervis* and *nanella,* two mutant forms.

In order to systematize the results general notes were made continuously upon the habits of the growing plants and formal comparisons were made at successive stages as follows :

First stage.— July 11th, 1902. The plantlets were nearly two months old and still retained the cotyledons.

Second stage.— October 15th, 1902. A distinct tap root had been formed and a rosette of leaves had been developed.

Third stage.— June 1st – 10th, 1903. Adult rosettes had been formed, and the smaller leaves which appear around the base of the stems were apparent. Some flowering stems were beginning to push up.

Fourth stage.— August 10th–15th, 1903. A number of inflorescences had been produced and flowers were opening daily in great profusion on some of the forms. Some of the inflorescences were enclosed in paper bags in order to secure pure seeds by means of artificial transfer of pollen.

The more apparent anatomical differences among the forms examined are shown quite strikingly by the series of photographs and drawings which illustrate this article.

The main fact to be kept in mind in regard to the parent form is that it is a recognized and constant species, which has not undergone noticeable alteration during the long period it has been under exact observation. The seeds from which the
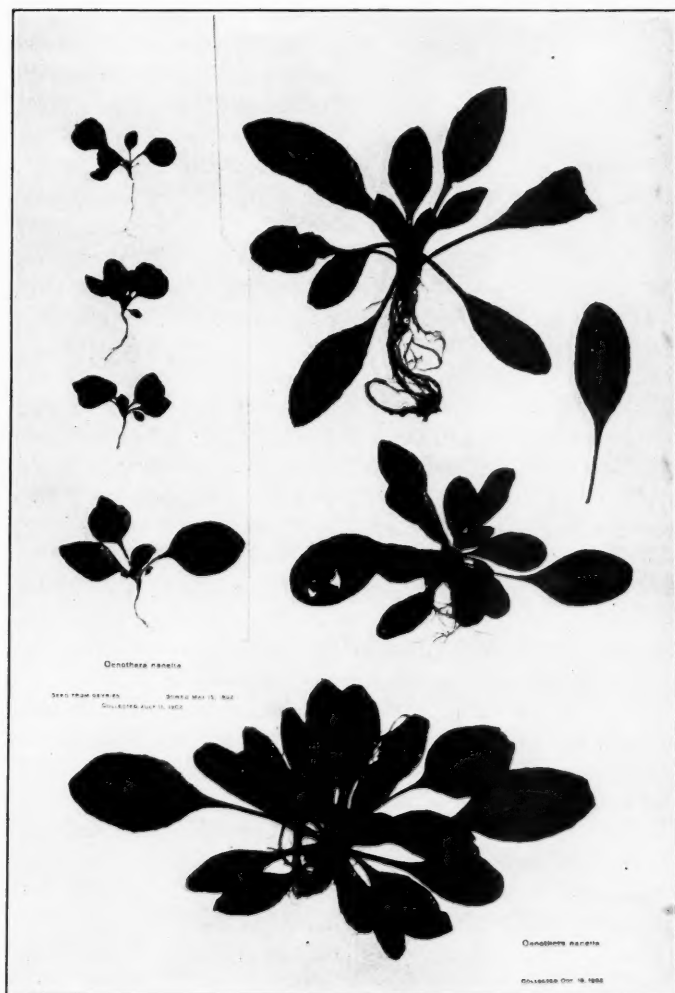
FIG. 3 —*(Enothera nanella.* Rosettes of seedlings two months, and five months of age. Photographed from herbarium sheets. (See Figs. 1 and 2.)

experimental material was derived were sown in a bed at s' Grave-
land near Amsterdam in 1875 and had been allowed to spread
over an adjoining neglected field until in 1884 an area of 2800
square meters was covered.   This material showed the presence
of a form so different from the parent type, when examined by
deVries in 1886, as to lead him to consider it as a new species,
and this mutant, *Œ. brevistylis*, which did not arise again during
the observations, maintained itself in the same locality during a
period of twelve years, records of it having been made as late as
1898, and it is still cultivated among the other mutants grown
by deVries and myself.   Other forms appeared during the
course of the next fourteen years as has been described in detail.

It was deemed advisable to make independent comparisons of
the plants grown in my own cultures with the type specimen
with which deVries identified his parent form, and to this end
Miss A. M. Vail made a visit to the herbarium of the Muséum
d' Histoire Naturelle in Paris, in May, 1903, at my request, and
also later a journey to Amsterdam and inspected the cultures
of *Œnothera* under Professor deVries's own guidance.   Miss
Vail has kindly prepared the following report on the matter :

"The parent form, *Œnothera lamarckiana* Ser. was found by
deVries to agree in every particular with two specimens in the
Muséum d'Histoire Naturelle in Paris.   These specimens con-
sist of, first : a plant cultivated in the Paris Garden that had
formed the basis of the original description of *Œnothera grand-
iflora* Lam. It bears a label indicating it as having been
included in the herbarium of Lamarck which was acquired by
the Museum in 1850.   On the margin of the sheet in the hand-
writing of Poiret (the author of the section dealing with *Œno-
thera* in Lamarck's Encyclopedia) is the following inscription
' Œnothera —(grandiflora)— nova spec. flores magni lutei, odore
grato, caulis 3 pedalis.'   This specimen is in flower only and
consists merely of the branched upper portion of the shoot with
numerous rather small leaves and conspicuously large typical
flowers.   The second specimen comes from the collection of
Abbé Pourret that was contained in the collections of Dr.

[1] For a brief general account of the experimental cultures, see MacDougal, The
Original of Species by Mutation.   *Torreya*, Vol. 2, pp. 65–68, 81–84, 97–100, 1902.

Barbier inherited by the Museum in 1847. It is filed in a cover with *Œ. biennis* L., and bears that name on the sheet, a small label inscribed with a series of prelinnean names, and another with ' *Onagra vulgaris* Spach ' and ' *Œnothera biennis* Linné,' both apparently in Spach's handwriting. This is the plant referred to by de Vries as having been collected presumably by Abbé Pourret in the Paris Garden during his visit in 1788. The specimen represents an unbranched upper portion of a shoot with numerous large well-developed leaves, partly mature capsules and several flowers that are somewhat smaller than those of the previously mentioned specimen. These two specimens differ in no important particular. Tracings of them compared with living plants grown in the New York Botanical Garden from seeds sent by de Vries agree quite perfectly.

"A search through the herbarium of the Muséum d'Histoire Naturelle and that of the New York Botanical Garden does not bring to light any specimen of a wild North American plant that can be referred to *Œ. lamarckiana* as it is now known and cultivated in Europe, nor does it seem to be known to collectors in North America at the present day.

"Several specimens were found however, which might be conjectured as representing a North American plant from which *Œ. lamarckiana* might have been derived. One of them is a plant collected by Michaux now preserved in the Muséum at Paris, and cited by de Vries in the Mutationsteorie (Bd. 1 : p. 316) and referred by him to a plant frequently cultivated in Europe under the name of *Œnothera grandiflora* Ait *Œ. suaveolens* Desf. but which he considers different from *Œ. lamarckiana*. A tracing was also made of this plant which consists of two specimens fastened on the same sheet upon which numerous inscriptions bear witness to much diversity of opinion as to its real identity. A small slip of paper bears in Michaux's handwriting ' *Œnothera grandiflora*,' another (the customary label of the Michauxian specimens) the inscription '*Œnothera grandiflora* Poiret Encycl.,' in the writing of that author of the section dealing with *Œnothera* in Lamarck's Encyclopedia ; beneath that ' *Œnothera suaveolens* Hort. par.' in the writing of Desfontaines, and lastly ' *Onagra vulgaris grandiflora* Spach.'

in the writing of Spach. The larger of the two specimens consists of a simple entire plant not fully developed, showing root, leaves, flowers, and capsules, but no basal leaves. The other specimen, which is smaller, is incomplete and fragmentary. A comparison of the tracing of the larger specimen with material in the herbarium of the New York Botanical Garden shows that it is identical with a specimen under the name of *Onagra biennis grandiflora* (Ait) Lindl., collected by E. S. and Mrs. Steel on Stony Man Mountain, Luray, Virginia, August 15th, 1901. The comparison also shows that the wild plant has undergone no change of any kind during a period of over a century.

"The following memoranda and citations may be of interest as throwing some light on the history of *Œ. lamarckiana* previous to 1788.

Linnæus in his Species Plantarum says that *Œnothera biennis* was brought from Virginia in 1614 and was then (1753) common in Europe. In Hortus Cliffortianus (1737) he states on p. 144, that it is a native of Virginia, having been brought from there to Europe 120 years before and was at the time he wrote spontaneous and plentiful in the fields of Holland. In Hortus Upsaliensis (p. 94. 1748) he gives the date of its introduction as 1620, then declared it to be spontaneous in Belgium, Italy, 'Gallia and Germania.' So that from the middle of the 17th century it was generally in cultivation in the botanical and horticultural establishments of Europe.

Referring to some of the prelinnean writers we find that Tournefort in *Inst. rei. herb.*, on p. 302 (1700) enumerates nine species of Onagra, the first four of which only are of interest here, as follows :

(1.)   *Onagra latifolia. Lysimachia lutea, corniculata.* C. B. Pin. 245.

(2.)   *Onagra latifolia, flore dilutiore. Lysimachia corniculata non papposa, Virginiana, major, flore sulphureo.* H. L. Bat.

(3.)   *Onagra latifolia, floribus ampliis. Lysimachia Virginiana, altera, foliis latioribus, floribus luteis, majoribus. Cat. Altdorf.*

(4.)   *Onagra angustifolia. Lysimachia angustifolia, Canadensis, corniculata* H. R. Par. *Lysimachia corniculata, lutea, Canadensis minor, seu angustifolia* Mor. H. R. Bles.

In the first of these references Caspar Bauhin in *Pinax* on p. 245 (1671) writes of an American evening primrose under the name of *Lysimachia lutea corniculata*, as being a Virginian Lysimachia growing in the Garden at Padua in 1619 and adds that it was a pleasing plant and easy to propagate from seed. The second reference goes back to Hermann's Catalogus, 1687, where on p. 396 he records a species of Virginian *Lysimachia* with sulphur colored flowers as growing in the Garden at Leyden. The third reference is to a plant with larger leaves and larger flowers from the Altdorf Garden. In Jungermann's *Catalogus plantarum quae in horto Medico Altdorphino reperiuntur* we read that a *Lysimachia lutea Fl. majoribus, odore Tabaci.* and a (Lysimachia) *Virginiana lutea Delphinium quorundum,* were known in the old Bavarian garden at Altdorf in 1635 and the statement is again repeated in another *Catalogus* in 1640. It was a sufficiently remarkable plant for Tournefort to note especially in his Institutiones, and it might be inferred that this large flowered plant from Altdorf was the ancestor of *Œnothera lamarckiana*. It would appear as if a form of what is generally claimed to be *Œnothera biennis* L. with delicate sulphureous flowers grew in the Leyden Garden and another with larger flowers in the garden at Altdorf. Under the same name, *Lysimachia corniculata*, an American evening primrose is said to have been growing in the Messina Garden in 1640 and it was known in the Paris Garden at about the same time or a little earlier and in 1653 in the Copenhagen Garden. Morison also records it as occurring in the Hortus Blesensis in 1669. This last reference is the one quoted by Tournefort as his fourth species. Again under the same name of *L. corniculata* Sherard speaks of it on p. 44 of his Schola Botanica as growing in the Paris Garden in 1689 and, presumably, descendents of the plants he saw were those collected by Abbé Pourret a century or so after and later made the type of the much discussed *Œ. grandiflora* Lem. = *Œ. lamarckiana* Sen. The plant described by Linnæus in the Species Plantarum was doubtless a composite species and it would be particularly interesting in this connection to know just what he meant by the plant described in the *Hortus Cliffortianus* as being plentiful in the fields of Holland. A tracing of the speci-

men which could be considered as the type of the plant described by him in the Hortus Cliffortianus has been kindly furnished by Dr. A. B. Rendle of the British Museum, and although the flowers are somewhat smaller than those of the living plants of Œ. *lamarckiana* as grown in the New York Botanical Garden nurseries, yet the general characters are identical, notably that of the entire or slightly emarginate petals. This character is certainly not typical of the wild weed-like Œ. *biennis* of waste lands
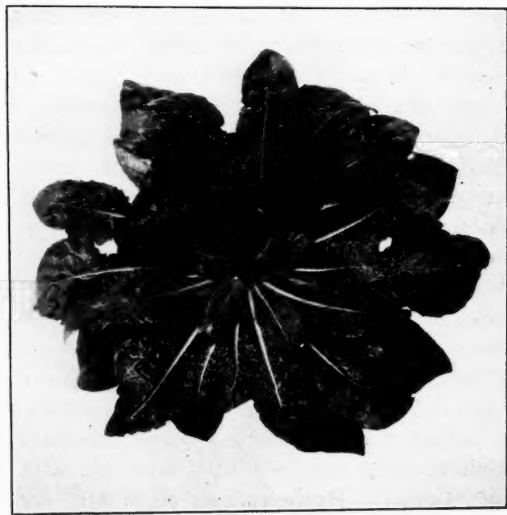

Fig. 4.—*Œnothera lamarckiana.* Adult rosette immediately preceding development of flowering stem. Photograph of living plant taken from directly above. (See Figs. 5 and 6.)

in North America to-day. In any case it seems extremely doubtful that all these cultivated evening primroses should be referred to so ungainly and unornamental a plant as Œ. *biennis.*

Prof. deVries in an article on the introduction of Œ. *lamarckiana* in Holland (Ned Kruidk. Arch. ser. 2, Vol. 6, p. 579, 1895) gives a long and detailed history of the ancestors of the plants taken into cultivation for his experiments. They were traced to plants escaped from cultivation and originally raised from seed received from a seedsman of Erfurt, Germany. Prof.

deVries also states that *Œ. biennis* and *Œ. muricata* are found in Holland, notably on the dunes.

It seems well established that a large flowered Œnothera was seen in the Altdorf Garden in 1635, which is probably referable to none other than *lamarckiana*. Later notes of its occurrence are in existence, but the first definite record of the species was
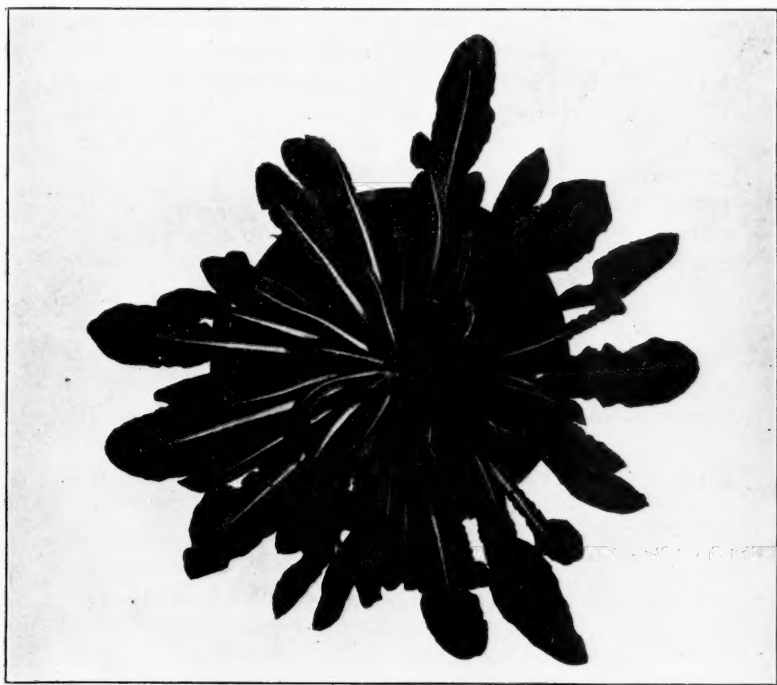

Fig. 5.—*Œnothera rubrinervis*. Adult rosette immediately preceding the development of the flowering stem. Photograph of living plant taken from directly above. (See Figs. 4 and 6.)

in 1788. It has been found constant since this date, both in gardens and when running wild : its evolutionary procedure is therefore none the less valuable as scientific evidence than as if it were an indigenous wild growing species.

Œnothera lamarckiana is a species which, so far as present

knowledge is concerned, has no exact duplicate in the native flora of any region, and two probabilities are suggested as to its origin: It may have been a native of a restricted range in "Virginia" in which it has been exterminated by agricultural operations, and hence cannot be found at the present time: or it may have arisen by some such sudden, and abrupt, discontinous variation, as that by which deVries' mutants came into existence, from *Œ. biennis* in the gardens, at Padua, Altdorf or elsewhere: at least no intermediate forms are known."

Only eleven specimens of hybrid seedlings derived from *Œnothera lata* were brought to the adult stage, in my cultures and of these but two conformed to the type of *Œ. lata*, the remainder being the *O. lamarckiana* form. *Œ. lata* does not perfect its stamens but it is capable of being pollinated from the parent. The offspring followed the laws governing parent and mutant hybrids, which with deVries were found to consist of 18% to 20% of the mutant type and the remainder of the parent. My own results agree with this. It is clear that this form would not have survived beyond the season of its appearance as it does not display any marked propagative capacity.

Œnothera nanella originated in deVries's cultures in 1888 and has since been followed by him through fifteen seasons. The qualities of this form separate it from the parent in such manner that it might be considered as a variety by some systematists, although its behavior and physiological properties are constant and very clearly distinguishable. In following out the development of the plant during the eighteen months over which my own observations extended it became evident that it differs most widely from the parent in its earlier, and also in its adult stages, being most like it in the full rosette stage. The most apparent feature is its diminutive size, both in the young plant and in the mature flowering shoot. The stem shows but little capacity for branching and did not reach a height of more than 20 to 25 cm. in my cultures, or about one fourth that of the parent, which sends out numerous vigorous branches. The first few leaves have very broad laminæ with irregular apical portions, and are short petioled. Later leaves are more nearly like the parent type but remain shorter petioled which has the effect of

making a denser more crowded rosette. The bases of the lam-
ina are almost cordate in some instances, and vary from oblong
ovate to ovate in outline, being sparingly toothed. The plants
established in the soil in the open air did not bloom until about
three weeks later than the parent and *Œ. rubrinervis*. No
noticeable departure from the characteristics assigned this form
by deVries was found.

Seedlings of *Œnothera rubrinervis* were seen to have nar-
rower leaves throughout from the earliest stages. The rosettes
were very closely appressed to the soil, and in this stage the
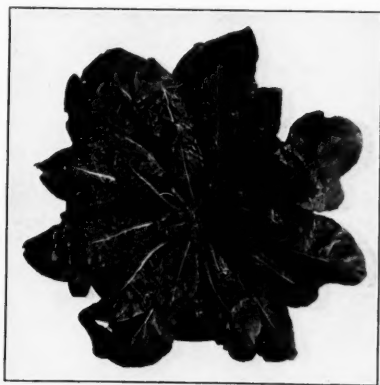margins of the long petiolate leaves were inrolled, thus decreas-

Fig. 6.—*Œnothera nanella*. Adult rosette immediately preceding the formation of flowering
stem. Photograph of living plant taken from directly above. (See Figs. 4 and 5.)

ing their apparent width. Attention is to be called here to the
fact that comparisons of leaf forms in plants of this kind
are permissible only between organs on corresponding por-
tions of shoots. The laminæ were more bluntly toothed than
those of the parent type, and the midribs occasionally bore a
tinge of red, while the entire shoot including the leaves of the
upper part of the stem showed a tendency to the formation of
anthocyan. The physical qualities of the leaf were strikingly
different from those of the parent, perhaps the most noticeable
feature being the great brittleness of the leaves and stems of

young plants, indicative of high turgidity and weak development of mechanical and supporting tissues.   Both of these characters have been observed by deVries, who notes that the bundles of

FIG. 7.—*Œnothera lamarckiana.*   Adult plant two weeks after beginning of opening of flowers.   Photograph of living plant grown in the soil in the open air, and temporarily fixed in a pot.   (See Fig. 8.)

bast fibers of the flowering stems were composed of elements with thinner walls than those of the parent type.

The leaves of the full rosettes, were silvery white owing to

the fact that the hairs on both surfaces were both longer and more numerous than on the parent type. The average length of the hairs on the upper surfaces was 35 as compared to 28 in the parent type, and on the lower surfaces 42 as compared to 30. The average number of stomata on a unit of area of the upper surface of the leaves of *rubrinervis* was 37 as compared

FIG. 8.—*(Enothera rubrinervis.* Adult plant two weeks after beginning of opening of flowers. Photograph of living plant grown in the soil in the open air, and temporarily fixed in a pot. (See Fig. 7.)

with 34 in *Œnothera lamarckiana*. The brittleness characteristic of the tissues of *rubrinervis* may be seen to extend even to the hairs, since these structures are easily detachable from the dried specimens, and hence giving rise to the conclusion that *rubrinervis* is less densely pubescent than *lamarckiana* as given in the systematic description below.

Still another major difference between the forms in general habit is that of the method of branching and the growth of the branches.   In *Œ. lamarckiana*, the branches from the basal portion of the shoot were of a length amounting to more than half that of the shoot which is also true of *Œ. rubrinervis*.   The upper branches of the former remain short and stout however, while those of *rubrinervis* attain greater lengths which decrease upwardly so that a plant may have a roughly globular outline.

The majority of the features in which the mutant departs from the parent, as described above, are of a nature that would equip the new form for living under more arid conditions than the parent, although the actual endurance of *rubrinervis* to decreased supply of moisture was not tested.   So far as this single observation goes then, it is to be seen that the new characters of mutants are harmonious in their adaptive relations.

Œnothera rubrinervis originated in deVries' cultures in 1899, and has also appeared by independent mutations since that time. It has been found to be independent and self-maintenant in competition with the parent form.

A large number of flower buds in both *rubrinervis* and *lamarckiana* were pierced by some insect, and the larvæ coming from the eggs deposited made great destruction, and also caused the abnormal enlargement of the buds and capsules, which failed to perfect seeds.

De Vries has continued to find the recurrence of some of the mutants in the successive crops of seedlings of *Œnothera lamarckiana* indicative of the fact that the mutating period of the parent has not yet been passed.   No departures from the parent type were found among the individuals which have come into bloom up to this time in the New York Botanical Garden.

The leaves of the seedlings of *Œ. lamarckiana* are easily distinguishable from those of *lata, nanella*, and *rubrinervis* even in the earlier stages, although not so easily separable from some of the other forms such as *brevistylis* and *leptocarpa* according to deVries.   The earliest leaves were ovate, or round-ovate with rounded apices, or sometimes slightly pointed.   These leaves as well as those formed at the age of five months were distinctly petiolate but with the laminæ relatively narrower.   Adult basal

leaves of the rosette in the period immediately preceding flowering were petiolate with the apices bluntly pointed and with broad laminæ. The margins of all of the earlier leaves were sparingly but sharply toothed.

Plants set out early in May were blooming profusely early in August. The basal branches coming out from the axils in or near the rosettes were strong and vigorous but the upper branches of the stem were short and offered a distinct contrast to the longer, more slender branches of *rubrinervis*, with which it was also contrasted by its denser foliage and larger more showy flowers. Both stems and branches were thicker and heavier than in *rubrinervis*.

After noting the great variance in behavior and appearance of the parent and two mutants as described above, mature plants in bloom, the dried material of the younger plants, and photographs were submitted to Dr. J. K. Small, who had previously published an arrangement of the American species, and who is familiar with them in (Small, J. K. Œnothera and its Segregates. Bull. Torr. Bot. Club. 23: 167–194, 1896.) the herbarium and in the field. Dr. Small has kindly prepared the following statement concerning three forms, which is given in full below:

The characteristics of *Œnothera lamarckiana* and *Œ. rubrinervis* as given by Dr. Small are set in parallel columns for convenience of comparison:

Oenothera lamarckiana Ser.

I. *Seedling about two months old.*— Leaves sparingly pubescent; blades ovate to suborbicular, the larger about 2 cm. wide, obtuse or rounded at the apex, each abruptly narrowed into a petiole.

II. *Seedlings 5 months old.* — Rosettes relatively dense : leaves copiously fine-pubescent; blades typically oblong, the larger ones fully 3 cm. wide, quite approximately denticulate, obtuse, or somewhat apiculate at the apex, much longer than the petioles.

III. *Adult plant.* — Plant very stout and luxuriant, 0.5 to 1 m. tall. Stem markedly channeled, sparingly hirsute with rather spreading hairs, nearly simple, or with several relatively short ascending branches near the base, and few very short ones above : leaves very numerous, 2–2.5 dm. long about the base of the stem ; blades shallowly and often irregularly toothed, those of the lower cauline leaves broadly spatulate to oblong, rather acute, each narrowed into a nearly semi-terete petiole, those of the upper cauline leaves oblong to oblong lanceolate, acute, or somewhat acuminate, short-petioled : bracts subcordate at the base : hypanthium 4.5–5.5 cm. long, about 8 mm. wide at the mouth, prominently ridged : sepals 4–5 cm. long, longer than the tubular portion of the hypanthium, the free tips 8–10 mm. long : petals firm 4–5 cm. long, emarginate : anthers 13–15 mm. long : stigmas 5–6.5 mm. long. (See Figs. 1, 4, 7 and 9.)

Oenothera rubrinervis deVries.

I. *Seedlings about 2 months old.* — Leaves manifestly less pubescent than those of *Oe. Lamarckiana*; blades elliptic, the larger ones about 1.5 cm. wide, acute or acutish at the apex, each gradually narrowed into a petiole.

II. *Seedlings 5 months old.* — Rosettes lax : leaves less densely pubescent than in *Oe. Lamarckiana*; blades spatulate to elliptic-spatulate or oblong-spatulate, the larger ones about 2.5. cm. wide, remotely denticulate, acute, or abruptly pointed at the apex, about as long as the petioles or shorter.

III. *Adult plant.* — Plant relatively stout, less luxuriant than *Oe. Lamarckiana*. Stem scarcely channeled, hirsute, with rather ascending hairs, typically branched throughout, the branches near the base elongated, decumbent, the upper ones gradually shorter : leaves numerous ; blades less prominently toothed than in *Oe. Lamarckiana*, those of the lower cauline leaves spatulate to broadly oblong, obtuse or acutish, each narrowed into a relatively long petiole, those of the upper cauline leaves elliptic-oblong to oblong or oblong-lanceolate, acuminate, short-petioled : bracts rounded or round-truncate at the base : hypanthium 5.5 to 6 cm. long, about 4 mm. wide at the mouth, obscurely ridged : sepals 3.3 to 3.5 cm. long, shorter than the tubular portion of the hypanthium, the free tips 5–6 mm. long : petals tender, 3–3.5 cm. long, notched : anthers 6–10 mm. long. stigmas 7.5–10 mm. long. (See Figs. 2, 5, 8 and 10.)

Œnothera nanella was taken by deVries to have a degree of separation from the parent type that would lead it to be considered as a variety, a conclusion which is borne out by Dr. Small's description as given below:

I. *Seedling about two months old.* — Resembles that of *Œnothera lamarckiana*; but the leaf-blades are less uniform, some of them ovate or oval, others ovate and somewhat lobed near the apex, others broadly ovate, or prominently apiculate.

II. *Seedling 5 months old.*— Nearly like that of *Œ. lamarckiana*; but leaves inclined to have longer petioles.

III. *Adult plant.*— Plant, stout and stocky in all parts, resembling *Œ. lamarckiana*, but smaller, less than 3 dm. tall. Stem obscurely channeled, hirsute with somewhat ascending hairs, simple: leaves approximate, 7–12, 5 cm. long near the base of the stem; blades shallowly, often rather remotely, but quite evenly toothed, those of the lower cauline leaves spatulate to oblong, acute, or acutish, each narrowed into a semi-terete petiole, those of the upper cauline leaves broadly oblong to oblong-ovate, acute or slightly acuminate, nearly sessile: bracts subcordate at the base: hypanthium 3–3.5 cm. long, about 5 mm. wide at the mouth, obscurely ridged: sepals 3–3.5 cm. long, longer than the tubular portion of the hypanthium, the free tips 5–6 mm. long: petals 3.5–4 cm. long, emarginate: anthers 11–12 mm. long: stigmas 4–5 mm. long.

General Summary.

Discontinuous variation as a possible method of origin of species was considered by Charles Darwin in his studies of plants and animals under domestication, and he concluded that if new forms did arise in this way that they were not self-maintenant (1868). On the other hand Galton took the position that the evolution of species is not necessarily by minute steps (1889), but Dollo (according to deVries's, *Mutationstheorie*, Bd. 1, p. 46, 1901) was the first to accept discontinuous variation as the prevalent method of origin of species (1893). Bateson (1894) brought together a large amount of evidence as to types which have arisen in this manner, and a comprehensive summary of
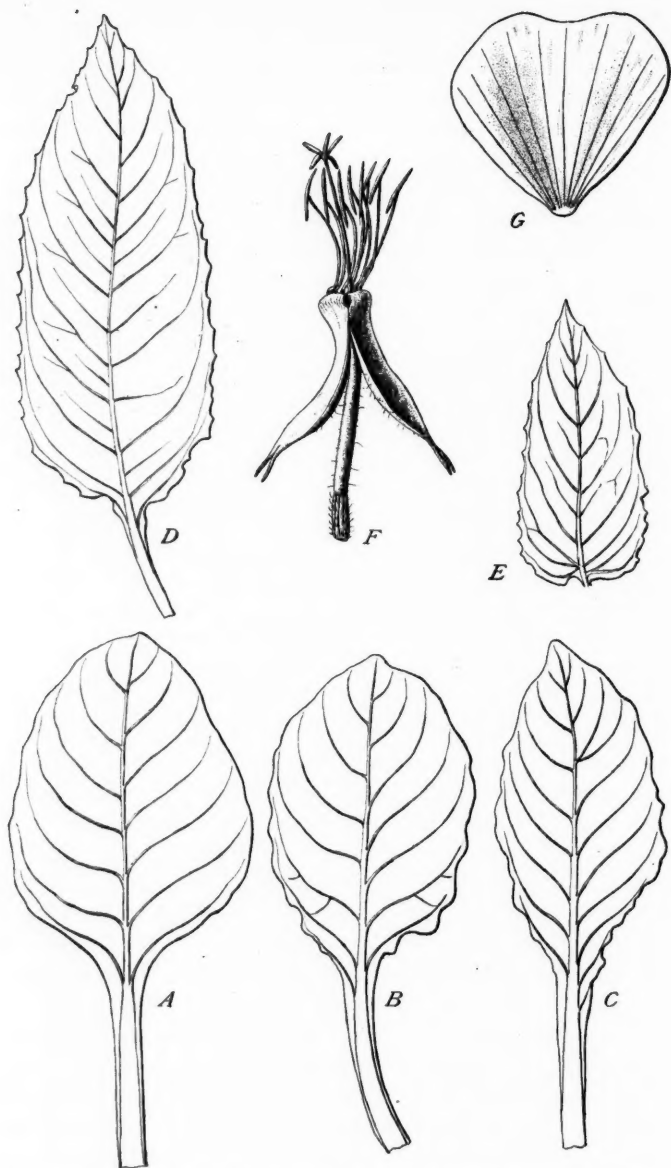
Fig. 9.—*Œnothera lamarckiana.* *A*, leaf from basal portion of adult rosette ; *B*, leaf from middle, and *C*, leaf from upper portion of rosette ; *D*, leaf from middle of flowering stem ; *E*, bract from lower part of inflorescence ; *F*, flower with petals removed ; *G*, petal. (See Fig. 10.)

FIG. 10.—Œnothera rubrinervis. A, leaf from lower part of adult rosette; B, leaf from middle portion, and C, leaf from upper portion of rosette; D, leaf from middle of flowering stem; E, bract from lower part of inflorescence; F, flower with petals removed; G, petal. (See Fig. 9.)
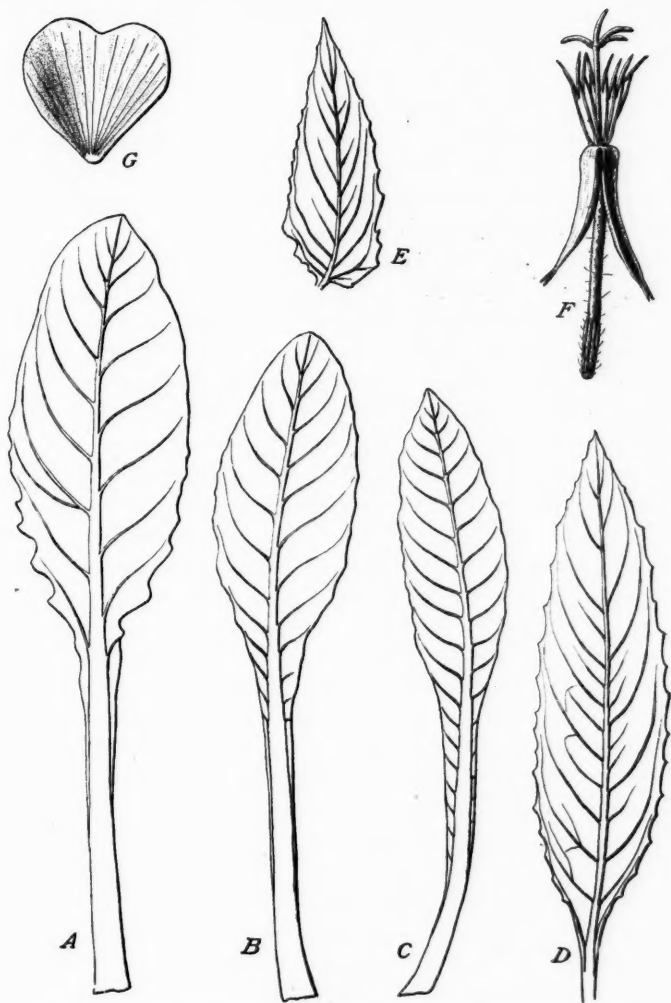
the principal evidence furnished by plants was made by Kors-chinsky in 1899.   Systematic observations upon the subject were begun by deVries in 1886 and have been continued until the present time.   As a result of his investigations deVries formu-lated his "Mutationstheorie," which has appeared in book form, the separate parts of which have been published in the period of 1901–1903.   This hypothesis rests upon the theory of pangenesis previously formulated by him.

The parent type, *O. lamarckiana,* from which deVries saw mutant forms arise has been found constant in its characters in cultivation in Europe and America and also when running wild. This type is not identical with any known member of the Ameri-can flora, and is most nearly allied to *Onagra biennis grandiflora* (*Oenothera biennis grandiflora*) from which it is suggested it might have arisen by mutation.

The mutant derivatives of the parent form are found to be constant in their characters, with no connecting or intergrading forms, as illustrated by the cultures of the parent, *Œ. nanella* and *Œ. rubrinervis*, in the New York Botanical Garden during 1902–1903.   The mutants are clearly separable from the parent and from each other both by physiological and taxonomic stand-ards.   Furthermore the specific character of the mutants was borne out by their behavior when hybridized with one another.

It has become evident from the results so far accomplished that the testing, study, proof or disproof of the theory of the origin of species by mutation involves an actual examination of lines of descent, and observations upon successive generations of organisms of known genesis.   In this manner only may mutant forms be distinguished from hybrids, individuals with aberrant non-transmissible characters and teratological formations. The nature of the questions involved, and the essentially mate-rial character of the evidence to be considered is such that all controversial discussions not supported by facts of this character must be viewed with distrust.   In no instance is this more plainly apparent than in the recent treatment of the subject by Vernon (Vernon, H. M. *Variation in Animals and Plants.* 1903). This author says " Hence it (*Œnothera lamarckiana*) is probably a garden variety of *Œnothera biennis* (Evening Primrose), and

may be a hybrid plant, whilst the mutations obtained by deVries may be merely partial or complete reversions to the original ancestors of the plant." It is quite possible, and even probable that *Œ. lamarckiana* may have been originally derived from the same type as *Œ. biennis* as noted above, but to designate it as a "garden variety," and as such ineligible as research material is simple evasion. The plant in question has been under more or less continuous observation for a hundred and fifteen years during which period it has been constant in its characters, and has shown no evidence by anatomical similarity or physiological behavior of being anything but an independent species. With what species could *biennis* hybridize to produce *lamarckiana*? The genus comprises a comparatively small number of types, all natives of America, and none of which were available as a hybrid mate to *biennis* at the time of the origin of *lamarckiana*. The conjecture in question is totally unsupported after the most rigid search for evidence upon the matter.

Again to consider the mutants as reversions to the original ancestors of *lamarckiana* is impossible, since the mutant forms exhibit qualities not possessed by any other known members of the genus, including *biennis*.

The point raised by Bateson and Saunders (Reports to the Evolution Committee. Royal Society. I. p. 153, London, 1902) that the pollen of *lamarckiana* contains deformed grains, which points to its origin by crossing, is without significance, since the author has found that the stamens of plants of *biennis* growing in the vicinity of New York exhibit a much larger proportion of deformed pollen than that of the specimens of *lamarckiana* cultivated in the New York Botanical Garden.

It has been impossible so far to assign mutations to definite causes, or to forecast the frequency, or occurrence of the phenomenon. These phases of the subject constitute the most important problems of the subject, which await investigation. Theoretical evidence upon such a subject can have but limited value, and conclusions of any satisfactory degree of finality may be expected only from direct experimental research under circumstances in which the probability of error is reduced to a minimum.

So far as the origin of mutations is concerned, it seems well decided that the premutative alterations in seed-plants ensue in the vegetative and sexual cells previously to the formation of the embryo in which they first appear, and that no environmental disturbances may bring about the alterations in question by direct action on the seedling.

It is not the purpose of this paper to discuss the various theories which have been put forward from time to time to account for the origin of species, but to bring under consideration the facts upon which the conclusions as to the origin of species by discontinuous variation have been based by deVries. These facts make inevitable the conclusion that new types of specific rank, taxonomically separable, and physiologically distinct and constant, without intergrading and connecting forms, have arisen in Œnothera by discontinuous variation. That mutation is the principal method of evolutionary procedure is not proven. That natural selection is universally prevalent is certainly disproven : that natural selection or any other method is capable of accounting for the existence of any single species has not been proven with the finality offered by the evidence of discontinuous variation. It may be said, therefore, that species have actually been demonstrated to have arisen by mutation, some are known to have arisen as the result of hybridization, and that evidence has been accumulated which has been interpreted to demonstrate the origin of species by natural selection, and by adaptation. Nothing in the nature of living organisms demands that all species should have originated in the same manner, or that one simple, or single method of procedure should have been followed.

New York Botanical Garden,
August, 1903.

DISTRIBUTION OF THE FRESH–WATER FISHES OF MEXICO.

SETH EUGENE MEEK.

MEXICO consists of a high plateau bordered on each side by a narrow coastal plain. It lies between the United States and Central America, but is not separated from either by natural boundary lines. The southern half of this country lies in the torrid zone, the rest in the North Temperate. Its geographical position, its elevation and diversity of climate make it, from a biological standpoint, a most interesting country. The Rocky Mountains extend into the northern United States as a single range to the Yellowstone Park. Here is given off to the west the Wasatch range, which extends south into Mexico as the western range of the Sierra Madre. The Rocky Mountains proper become in Mexico the eastern range of the Sierra Madre. These two mountain ranges include a plateau, the elevation of which varies from three to eight thousand feet above the sea. This plateau is drained by four river systems :— the Colorado river on the north and west, the Rio Grande, central and eastern portion, the Rio Panuca and the Rio Lerma, the southern portion. The southern end of this plateau is the beautiful valley in which is built the City of Mexico, while the two mountain ranges culminate in the famous peaks of Ixtaccihuatl and Popocatapetl. The valley of Mexico though at one time it probably drained into the Lerma now comprises a drainage system of its own. The great central plateau comprises the larger part of Mexico. On the east and the west is a low narrow plain from which the ascent to the plateau is steep. South of the valley of Mexico the mountains extend as one range through Central America to become the Andes in South America. The Mexican plateau in general is a treeless plain, covered with only a slight vegetation.

The Yucca, the Mesquite, various species of Cacti, sage brush, a few stunted cedars and the like, together with a sparse growth of various species of grasses, comprise the larger part of the vegetation of this region. During the rainy season and a

771

short time after it, there is a luxuriant growth of vegetation : but after a few months of exposure to the piercing rays of a tropical sun the character of the country changes, and it assumes the air of a parched desert. It is subject to a short rainy season and a long dry one. The rivers which are large in the rainy season become almost dry by the end of the long dry season. Many of the lakes in northern Mexico become dry and the streams which flow into them contain but little water except in the upper part of their courses where they are fed by mountain springs, and streams of this character contain but few species of fish.

The study of any group of plants or animals in a country like this is very interesting, but no group of living things presents a more interesting subject for the study of geographical distribution than the fresh water fishes. Living as they do in the water their only highways of travel are in the streams and lakes and so their dispersion is largely governed by the formation of our fresh water lakes and rivers and is therefore intimately associated with the later chapters of the geological history of the earth.

The two large rivers which reach Mexico from the north and which have furnished highways by which Northern Mexico became stocked with fishes are the Colorado and the Rio Grande. The former flows into the Gulf of California, the latter into the Gulf of Mexico. In their upper courses these two rivers are near each other, but their fishes are not the same. The only fish common to both river basins is a small dace (*Rhinichthys dulcis*) and this is also found in the head waters of the Arkansas, the Missouri and the Columbia rivers. From the Colorado river there are known 32 species of fishes which are distributed in 18 genera and 5 families.[1] Of these 32 species all but 10[2] are thus far known only from this basin. Nine of

---

[1] Catostomidæ (Suckers) 9 species, Cyprinidæ (Minnows) 18 species, Salmonidæ (Trout and White fishes) 2 species, Poecilidæ (Killifishes) 2 species, Cottidæ (Blobs) 1 species.

[2] *Leuciscus lineatus* (Girard), *Rhinichthys dulcis* (Girard), *Agosia chrysogaster* Girard, *Agosia oscula* (Girard), *Lepidomeda vittata* Cope, *Coregonus williamsoni* Girard, *Salmo spilurus* (Cope), *Poecilia occidentalis* (Baird & Girard), *Cottus punctulatus* (Gill).

Map of Mexico showing fish faunal areas.

these exceptions belong to other western streams, the other species (*Rhinichthys dulcis*) is found in all rivers whose sources are in the Rockies. Of the 18 genera 4[1] are thus far known only from the Colorado basin.

More than half of the Colorado fishes are minnows (Cyprinidæ), and of these the white salmon (*Ptychocheilus lucius Girard*) is the largest member of the family. In the Colorado River specimens of this species are occasionally taken which reach a weight of 80 pounds. The blob (*Cottus punctulatus*) is the only spiny-rayed fish known from this basin.

Up to within the past year and a half very little was known concerning the fishes of the Rio Yaqui, the largest river in Northwestern Mexico. The few fishes previously taken in that river indicated that its fauna was that of the Colorado. The finding of a bull-head in this basin in 1896 seemed a little strange and it was difficult to account for its presence there. With these facts in mind, when I was collecting fishes in Chihuahua it was with no small amount of interest that I visited Lago de Castillos which is a part of a small river basin between the head waters of the Rio Conchos and the Rio Yaqui. At Castillos I found only the Rio Grande chub. In the Yaqui I also found this chub, and a number of species I had taken in tributaries of the Rio Grande, at Chihuahua, and San Andres.

Of 14[2] species known from the Rio Yaqui, 9 (listed below in bold type) have been taken in the Rio Grande basin, 2[3] have been found no where else; one of these (*Gila minacæ*) belongs to a genus peculiar to the Colorado river basin, the other (*Catostomus sonorensis*) belongs to a genus well represented in both the Colorado and Rio Grande. Of the remaining 3 species 2 (*Agosia chrysogaster* and *Pœcilia occidentalis*) belong to the Colorado river fauna. In the lower portion of the Rio Sonora

[1] Xyrauchen, Tiaroga, Meda, Plagopterus.

[2] *Ameiurus pricei* (Rutter), **Pantosteus plebius** (B. & G.), *Catostomus bernardini* Girard, **Campostoma ornatum** Girard, **Pimephales confertus** (Girard) *Gila minacæ* Meek, **Leuciscus nigrescens** (Girard). *Notropis ornatus* (Girard), **Notropis lutrensis** (B. & G.) *Agosia chrysogaster* Girard, **Salmo spilurus** Cope, **Cyprinodon elegans** (B. & G.) *Pœcilia occidentalis* B. & G.

[3] *Catostomus bernardini* and *Gila minacæ*.

3 or 4 [1] species which belong to the Colorado river fauna have been taken.

The presence of so many fishes from the Rio Grande basin can be thus interpreted:— The head waters of the Rio Paphig-ochic, a tributary of the Rio Yaqui, lie east of the central
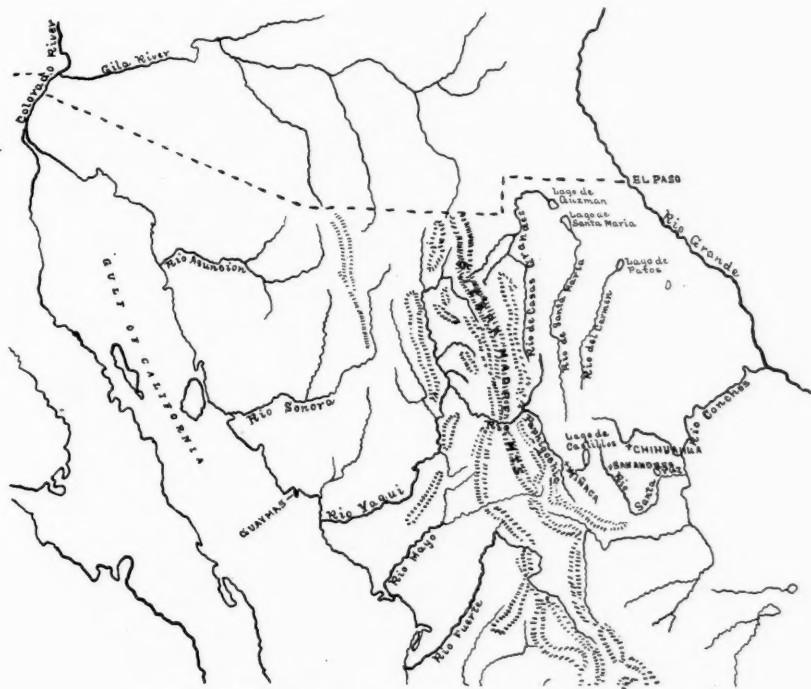
Map showing head waters of the Rio Yaqui and a western tributary of the Rio Grande.

range of the Sierra Madre mountains. That portion of this stream no doubt formerly had its outlet through Lago de Castil-los into the Rio Conchos and in this way became stocked with fishes from the Rio Grande.[2] The fact that the fauna of the

[1] *Catostomus bernardini* Girard, *Phychocheilus lucius* Girard, *Agosia oscula* (Girard), *Pœcilia occidentalis* (Baird & Girard).

[2] A collection of fishes was made recently by the writer in the Rio Mezquital at Durango. This collection has not yet been studied; it is however composed largely of Rio Grande species.

Rio Yaqui is so much like that of the isolated river basins in northern Mexico rather strengthens this belief, though its ultimate proof must depend on the geologist.

In Northern Chihuahua west of the Rio Grande and adjacent to the head waters of the Gila river, the Rio Yaqui and the Rio Conchos, there is a considerable area which is drained by several small river systems, all of which have no outlets. Five of these small basins have been examined as follows : the Rio Carmen which drains into Lago de Patos, the Rio Santa Maria which drains into Lago de Santa Maria, the Rio Casas Grande which drains into Lago de Guzman, the Rio Castillos which drains into Lago de Castillos, and a small stream at Sauz, in the state of Chihuahua. During the rainy season the water collects in the lowest portion of these valleys forming large lakes. Most of these lakes become quite or entirely dry by the end of the dry season, but there is always enough water in the upper courses of the rivers which flow into them to sustain a considerable number of fishes. All of these streams were at one time a portion of the Rio Grande. These five basins have not been equally explored, though it is likely that all have about the same fauna. From these basins have been taken 10 species [1] of fishes.

Of these 10 species none has been recorded from the Gila river or the Rio Sonora. All except 3 (*listed in bold type*) are reported from the headwaters of the Rio Yaqui in Chihuahua, and from the Rio Conchos. The three exceptions are species closely related to *Notropis lutrensis*, an extremely variable and widely distributed minnow, and which is abundant in both of these rivers. One other minnow (*Notropis ornatus*) is

---

[1] *Pantosteus plebius* (B. & G.). Casas Grandes ; Rio Carmen ; Sauz.

Compostoma ornatum Girard. Casas Grandes.

Pimephales confertus Girard. Casas Grandes ; Santa Maria.

Leuciscus nigrescens (Girard). Casas Grandes ; Santa Maria ; Carmen Castillos ; Sauz.

Notropis frigidus Girard. (Identification doubtful), Santa Maria.

Notropis santamariæ Evermann & Goldsborough. Santa Maria.

Notropis formosus Girard. Casas Grandes.

Notropis lutrensis (B. & G.). Casas Grandes ; Santa Maria ; Carmen ; Sauz.

Cyprinodon elegans (B. & C.). Casas Grandes ; Santa Maria ; Carmen.

Gambusia affinis (Baird & Girard). Sauz.

common to both the Rio Conchos and Rio Yaqui, but at present is not known from any of the four small river basins. No other species than those here mentioned is known to be common to the Rio Yaqui and Rio Conchos.

Aside from the five small river basins mentioned above there
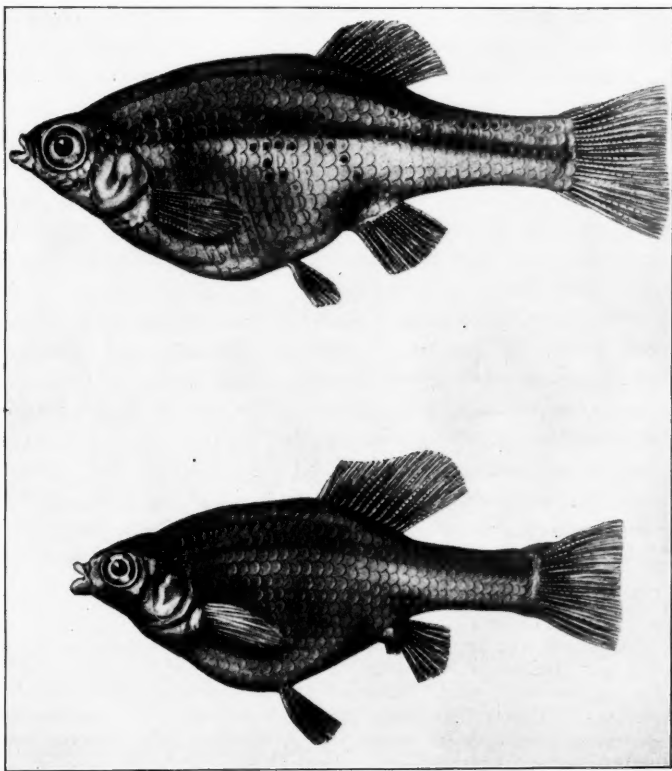
Skiffia ermæ Meek, ♀..
Skiffia lermæ Meek, ♂.

are in central Mexico several others with no outlet to the sea, of which the Rio Nazas is the largest. From a number of these no collections of fishes have been made, though their fishes so

far as known are that of the Rio Grande. From the Rio Nazas are known 12 [1] species of fishes, 6 of these (listed in bold type) have been taken in the Rio Grande or its tributaries, all of the others except *Stypodon signifer* and *Characodon garmani,* belong to genera well represented in the Rio Grande. The genus Stypodon is known only from the Rio Nazas, and Characodon is a tropical genus. Every large lake or river, as a rule, contains one or more species of fishes not found in other localities.

It is evident that the larger number of the Rio Grande fishes have migrated directly or indirectly from the Mississippi valley, 23 of its 85 species being found in the Wabash in Indiana. This fauna has crowded its way over the divide and has become more firmly established in the Pacific coast streams of Sonora than has the Colorado river fauna, and one species (*Notropis nigrotæniatus*) at least has gotten as far south as the Rio Balsas in southern Mexico.

The southern portion of the Mexican plateau is drained by two rivers: the one to the east, the San Juan del Rio, is a small stream which flows into the Rio Panuco. The other, the Lerma, flows into the Pacific. The Lerma is the longest river in Mexico. The valley of Mexico was formerly a part of the Lerma drainage system. The fish fauna of this region is very different from that either to the north or the south. From the area which includes the valley of Mexico,[2] the head waters of the San Juan del Rio [3] and the Lerma basin, are known at present 49 species of fishes, not one of which is known to occur

---

[1] **Ameiurus** *prici* Rutter, **Carpiodes tumidus** Girard, *Pantosteus nebuliferus* (Garman), **Hybognathus punctifer** Garman, *Stypodon signifer* Garman, **Leuciscus nigrescens** (Girard), **Leuciscus modesta** (Garman), *Notropis garmani* Jord. & Ev., **Rhinichthys simus** Garman, *Cyprinodon latifasciatus* Garman, *Characodon garmani* Jordan & Evermann, **Etheostoma pottsii** (Girard), **Etheostoma australe** Jordan.

[2] The following is a list of the fishes known from the Valley of Mexico, those printed in bold type are peculiar to this region.

Algansea tincella (C. & V.), **Aztecula azteca** (Woolman), **Evarra eigenmani** Woolman, **Evarra tlahuacensis** Meek, *Girardinichthys innominatus* Bleeker, *Zoogoneticus miniatus* Meek, **Skiffia variegata** Meek, *Chirostoma jordani* Woolman, *Chirostoma humboldtianum* (C. & V.), *Chirostoma estor* Jordan.

[3] List of species known from the headwaters of the San Juan del Rio.

Algansea tincella, **Aztecula mexicana,** *Goodea caliente.*

in any other river. These 49 species belong to 17 [1] genera, 10 of which are peculiar to this region.

Of the genera found elsewhere, Characodon is represented in southern Mexico, central America, and lower California. Gambusia comprises a number of small viviparous fishes usually inhabiting swamps and springs all the way from Southern Illinois to Panama. The other five genera, Lampetra, Ameiurus, Moxostoma, Notropis and Hybopsis are northern genera, and all except Notropis are not represented by any species farther south than the Rio Lerma. Of the 49 species found in this region, 33 belong to two families; 17 to Pœciliidæ (the Killifishes) and 16 to Atherinidæ (the Silversides). It is curious to note here that all of the killifishes are viviparous, yet only one species, *Gambusia infans* Woolman, has the anal fin of the male placed well forward and modified into an intromittent organ such as is characteristic of Heterandia, Pœcilia and the like. In the other 15 species the anal fin of the male has its normal position and size. It is slightly modified by the shortening of the first five or six rays, and their slight separation from the rest of the fin by a shallow notch. This modification was first noticed by Günther in *Characodon lateralis* Gunther. It was also described by Bean in *Zoogoneticus robustus* (Bean), and by Jordan and Snyder in *Goodea caliente* J. &. S. but no significance was attached to it. Just what part this fin plays in fertilizing the eggs in the body of the female is not known, but it evidently plays a porminent part in this operation.

I was fortunate to collect these fishes during the breeding season and so their viviparity was easily proved. The largest killifish known from the Lerma Basin reaches a length of 8 or 10 inches. The accompanying figures are made from a photograph of the largest female of this species I was able to obtain. It was purchased from a fisherman who did not suppose it would find its way into a distant museum and this explains its rather dilapidated appearance. The ovary consists of a membranous

---

[1] The genera in italics are peculiar to this region.

Lampetra 1, Ameiurus 1, Moxostoma 1, **Algansea** 4, **Aztecula** 3, Notropis 1, **Xystrosus** 1, **Evarra** 2, **Falcula** 1, Hybopsis 1, **Zoogoneticus** 5, Girardinichthys 1, Characodon 2, **Chapalichthys** 2, Gambusia 1, **Goodea** 7, Chirostoma 16.

sack with a number of infolded partitions. Removing a portion of one side shows the ovary full of quite well developed young. The little fishes in it are not arranged in any definite order.

The spawning time for these fishes is near the close of the dry season. At this time the water is more concentrated, as is also the food on which the young must feed. The aquatic insects, crustaceans and small fishes which would feast on the eggs if deposited then are also more concentrated, so that depositing the eggs at this time would mean considerable destruction to the species. As it is, the young are born in a well developed stage, and have time to reach some size before the wet season sets in. They are then perhaps in the best condition to become widely distributed as the volume and area of water increases. As the dry season approaches again, and small streams and ponds become dry, many of these small fishes perish. They are, however, present everywhere to establish themselves in every body of water which may carry them through to the next rainy season.

The gestation of many tropical fishes presents some strange peculiarities. Some of the catfishes carry the eggs in the mouth till hatched, while a few others are thought to be viviparous. Viviparity among the tropical killifishes in general seems to be the rule rather than the exception. It would seem that in the tropical fresh waters of America, there is much more provision made for the care of the young than in the cooler waters of the Northern continent.

It was rather surprising to find such a large number of Chirostoma in the Lerma basin ; no other river in North America indeed, has so large a proportion of its fishes belonging to a salt water [1] family. It is probable that this number will be considerably increased when this basin is more thoroughly explored. I had seen but a few specimens of Chirostoma before going to Mexico, and so never had an opportunity to study these fishes. And while I was careful to pick up specimens of all species, yet my unfamiliarity at that time with the group, no doubt, caused me to overlook some species. Again there is a number of small

---

[1] The Chirostoma are the only fishes belonging to a salt water family found on the Mexican plateau.
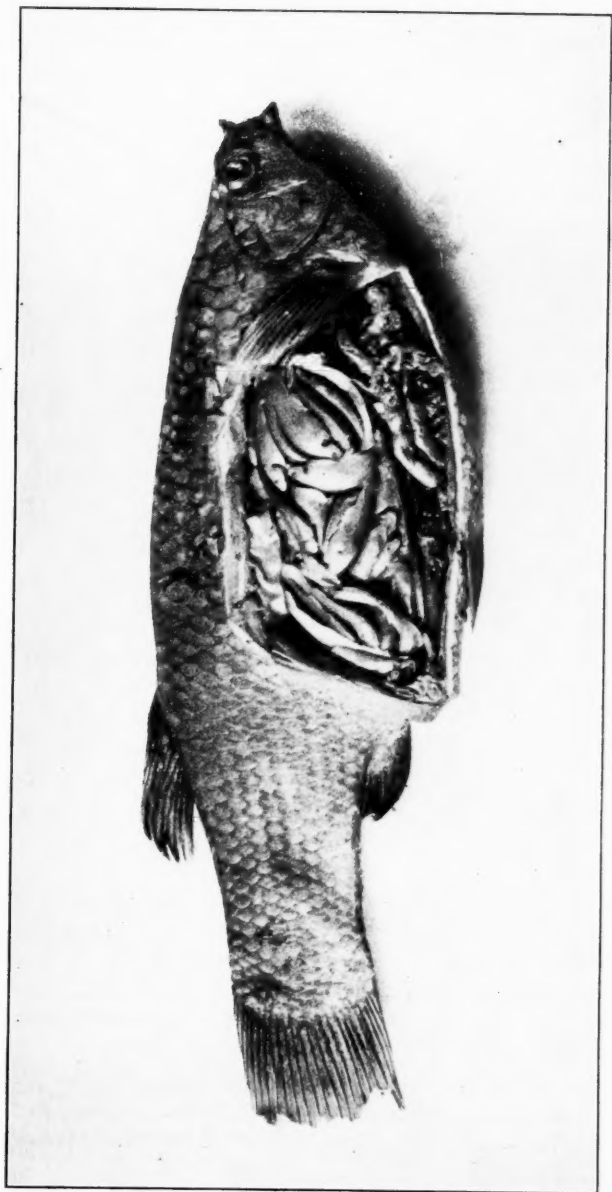
Goodea luitpoldi (Steindachner), with ovary containing young.

isolated lakes which have never been visited. It is known that some of these lakes, as Patzcuaro and Zirahuen, have in them one or more characteristic species and no doubt most of them have. The Lerma river system is far from being thoroughly explored, but apparently its fish fauna is quite as distinct and characteristic as if it were an island in the sea.

All of the many beautiful lakes in this area, now isolated, evidently at one time drained into the Lerma, and so became stocked with fishes. It is often argued that fishes become established in isolated lakes by their eggs being carried accidentally by water birds. Although while these birds are feeding some eggs of fishes might cling to their feathers or legs and be taken to adjacent waters, yet I much doubt the dispersion of fishes in this way. Were this method of dispersion at all common fishes would surely have been found in Shoshone and Lewis lakes in the Yellowstone Park; moreover in the isolated lakes in the valley of the Lerma the viviparous fishes are about as evenly distributed as are the egg laying ones.

The Rio Balsas is one of the largest rivers in Mexico. It is southeast of the Lerma and drains about the same area; and though these two rivers are so near each other, not a single species is known to be common. But one species of the silverside and two of killifishes, are known from the Balsas, and yet these two families comprise nearly two thirds of the fishes of the Lerma basin. The Balsas is far from being thoroughly explored; enough, however, has been done to indicate the nature of its fauna and to indicate that it contains comparatively few species of fishes.

In Mexico there are four quite distinct fish faunas, and though they overlap at the borders, the map may fairly indicate where each fauna prevails.[1] The origin of these fish may be approximately given as follows: from the Colorado river 9, from the Rio Grande 80, from the Lerma 49, and from Central America about 108; total 246.

The fish fauna of northern Mexico is essentially that of the Rocky Mountains and eastern United States, or that part of the United States adjacent to Mexico. This eastern fauna has

[1] The fishes of the region marked unknown probably belong to the Rio Grande fauna.

crowded its way over the divide and has become even more firmly established in the Pacific coast streams of Sonora than has the Rocky Mountain fauna.

The South and Central American faunas prevail largely as far north as the City of Mexico. The few forms which extend farther north apparently keep to the lowland streams ; especially is this true on the Pacific side. The most northern representative of the South American fauna, one of the Cichlids,[1] is found in Mazatlan. On the east coast this family has a representative in Texas. The fauna of the Lerma, the only river basin extensively studied, is quite distinct from either North or Central and South America. This fauna is richer and more characteristic than was formerly supposed.

Mexico in general is not a well watered country. Nearly all of the small streams and many of the large ones become much reduced in size by the end of the long dry season, and such streams never sustain a large number of species of fishes. On the Mexican plateau the largest and most important lakes are found in the Lerma basin ; Lake Chapala, the largest and the only one which has a large river for outlet and inlet, sustains the largest fish fauna. Patzcuaro, a large lake with no inlet or outlet does not have so varied a fauna, but supports a large number of individuals. In view of the fact that more species of fishes belong to tropical Mexico than to a like area farther north it seems strange that a great river like the Balsas which lies wholly within the tropics should contain so few species. This river is fed by many mountain springs, and even in the dry season contains an abundance of clear water. Collections of fishes have been made at but three places in this river basin, and in all only 11[2] species of fishes taken, a number much fewer than one would expect.

[1] The name Mojarra is used for the Cichlids in Mexico, it is also much used on the plateau for the larger Pœcilidæ.

[2] *Istlarius balsanus* Jordan & Snyder, *Algansea sallæi* (Gunther), *Notropis nigrotæniatus* (Gunther), *Tetragonopterus mexicanus* Filippi, *Gambusia gracilis* Heckel, *Pœcilia limantouri* Jordan & Snyder, *Chirostoma jordani* Woolman, *Melaniris balsanus* Meek, *Agonostomus nasutus* Gunther, *Heros istlanus* Jordan & Snyder, *Awaous taisiaca* (Lich.).

Algansea sallæi and *Chirostoma jordani* are in my opinion wrongly ascribed in this river basin.

From many lakes and rivers in Mexico no collections of fishes have been made. In conclusion I will say that since the fish fauna of Mexico is far from being thoroughly explored, the faunal areas as I have outlined them, and their origin and probable lines of dispersion must be regarded as tentative.

FIELD COLUMBIAN MUSEUM.
　　Chicago, June, 1903.

EXAMINATION OF ORGANIC REMAINS IN POSTGLACIAL DEPOSITS.

Pehr Olsson-Seffer.

Little or no attention has been paid in America to the study of fossil plants in the postglacial deposits. They do not offer such a fascinating field to the investigator as the tertiary and other older formations. They do not show a multitude of forms of animal and vegetable life, beautifully preserved from the times when the earth was young; only a few fragments of recent types, difficult to determine and mostly of a very diminutive size, necessitating a constant use of the microscope. But they are, nevertheless, interesting, especially to the student of descriptive phytogeography, as recorders of the history of the vegetation, and to some extent as indicators of climatic conditions in times gone by. In this respect the great importance of an investigation of, for instance, the formation of peat-bogs, cannot be overrated, and in northern Europe this study has developed during the last decades into a special science, called in Germany *Moorkunde*. A name of a more international character, telmatology,[1] has been used by some authors,[2] and seems acceptable.

The Scandinavian countries, especially Sweden, have been the center of this study, and consequently, the development of the Scandinavian Flora and vegetation is better known at the present day than that of any other part of the world.

It is the purpose of this paper to give a brief review of the methods for collecting, preserving and examining the plant-remains in recent deposits, as these methods are now generally employed by paleobotanists, with a few additions from the writer's experience in the study of telmatology. In another

[1] From **Τέλμα** = swamp or bog.

[2] Klinge, J., for example, nearly twenty years ago. Not having access to the literature, I cannot at the time of writing, ascertain who proposed this name. G. Lagerheim suggested (1902) a name derived from **Ηαύσιμος** *i. e.* = combustible, but both priority and suitability speak in favor of Telmatology.

place the development of these formations and their relation to certain plant-communities will be treated.

Japetus Steenstrup of Copenhagen was the first to begin the difficult task of identifying the organic remains in peat bogs and similar deposits. After him Axel Blytt of Christiania, A. G. Nathorst and Gunnar Andersson of Stockholm, Rutger Sernander and Henrik Munthe of Upsala have been the principal workers in this field. Many pupils of Andersson and Sernander have in later years pursued the study in Germany, Russia and other countries, and the literature on the subject is rapidly increasing.

The first paper on the method of examining fossil plants in postglacial deposits was published by Andersson in 1892.[1] Improvements on his method were made known in 1892, 1893 and 1896.[2] Munthe gave (1894) a detailed account of biological investigation of clays,[3] and Professor G. Lagerheim[4] recently ('02) related some new experiences with regard to the technique of telmatological research.

All these papers are in the Swedish language and the writer thinks he is justified in bringing the methods in question under the notice of American paleobotanists and phytogeographers, as a study of the evolution of the plant-covering based on paleontological testimony is likely to find adherents in the United States and Canada, where postglacial deposits, so widely distributed and covering immense areas, offer special advantages for this line of research.

The principal kinds of recent deposits in which we meet with fossil plants, are fresh water alluvium, lacustrine deposits and peat bogs. Wherever these formations are developed, accumulation of partially decomposed organic matter has been the most important agent in their construction.

When this process of decomposition is proceeding in presence

---

[1] Om metoden för växtpaleontologiska undersökningar af torfmossar. *Geolog. fören. förh.* Stockholm, vol. XIV, pt. 2, pp. 165–175.

[2] Om slamning af torf, *loc. cit.* vol. XIV, pt. 6, pp. 506–508 ; Om metoden for botanisk undersökning af olika torfslag. *Svenska mosskulturförening. tidsk.*, 1893, and Om konservering af kvartära växtlämningar. *Geolog.fören. förh.*, vol. XVIII, pt. 6, pp. 492–498.

[3] Om biologisk undersökning af leror. *Geol. fören. förh.*, XVI, pt. 1, pp. 17–28.

[4] Torftekniska notiser, *loc. cit.*, XXIV, pt. 6, pp. 407–411.

of an excess of water, humic acid and certain hydro-carbons are formed, and it is to these substances the said deposits owe their anti-septic properties, which make it possible for organic remains to resist decay for a sufficiently long time to allow deposition of the sediment, in which they are finally imbedded.

Trees falling into the water, branches, roots, leaves, seeds, and other parts of plants are often in this way preserved, and retain sometimes their shape, color and anatomical structure to a surprising degree, so that there is no difficulty in discriminating the distinct species. It is, however, only lignified and corky tissues that are able to resist decomposing. All those organs which have not cell-walls modified in this way, are liable to be destroyed. Of leaves, for instance, only the epidermis and vascular bundles remain, while mesophyll and similar tissues decay.

The fossil remains are therefore often quite different in appearance from the plants that fell into the water, where they were deposited. Among Salices that are found in post-glacial deposits, species with hard leaves, as *Salix aurita* L., *S. cinerea* L. and *S. nigricans* Sm. remain unaltered, both with regard to form and consistency, although, of course, the color is changed ; the nervation is very distinct. In the case of *S. myrsinites L.* only the skeleton of the ribs is left. *S. lanata* L. and *S. lapponum* L. are very difficult to recognize, because the characteristic tomentum has disappeared, and instead, the nervation, which in the living condition cannot be traced, is rendered very conspicuous.

In beginning the study of telmatology one of the greatest difficulties met with is the fact that there are, as yet, only a few study collections accessible, and no complete works of reference with excellent illustrations and descriptions such as are available in other branches of paleontology. The student has usually to prepare for himself the comparative material he wants.

By means of certain maceration processes the same effect can be accomplished in a few minutes in the laboratory that required a long time in nature. Thus it can be also ascertained to some degrèe of probability, whether a certain plant can be preserved in a fossil state in mud, peat, and clays, or if it will be completely decomposed when subjected to the influence of water and other agencies in the deposits.

For this purpose the plant is boiled in Schultze's maceration mixture, which consists, as every botanist knows, of potassium chlorate and nitric acid. Leaves, seeds and other parts of the plants, which are usually found fossil, soon acquire the same dark-brown color that is so characteristic for peat, and it is almost impossible to distinguish these preparations from the real fossils. Plants, however, which are almost instantly destroyed by this strong reagent, never occur in the said deposits. It can, therefore, be taken for granted, if the tissues are destroyed within a minute or two, that the result would have been the same in water, but if only bleached, or in a lesser degree macerated, it can be supposed that the organ would have resisted decomposition.

These macerated objects can then be mounted and preserved in the way usually adopted for microscopic preparations. Every student of fossils in postglacial deposits should in this way secure the material needed for comparison.

The collecting of fossils consists partly of field work and partly of operations in the laboratory. For the former purpose the student should be supplied with the following tools. A small steel spade, about 20 cm. in length and 14 cm. in width, with a handle like that on a mason's trowel, and with sharp edges, for cutting purposes ; a pointed knife with a blade of at least 14 cm. in length ; a pair of forceps, a soft camel's-hair brush ; a white china plate ; and a pocket microscope. Further, a number of flat-bottomed test-tubes of different sizes : 60 x 18 mm., 50 x 16 mm., and 40 x 12 mm being the most suitable sizes ; strong, wide-mouthed glass bottles, 80 x 40 mm., and some glass jars of about 12 cc. capacity.

If collecting is done in deposits more or less petrified and hard, such as calcareous sinter or tuff, the usual tools of a geologist are needed.

Sometimes it will be found impossible to remove fossils found in loose sand deposits, because they are too brittle, and in such cases it is advisable to fix the sand particles together with water glass, as silicate of potassium or sodium, readily and completely soluble in water generally are called. Although the fossils preserved in this way lose their color, and if not prepared most

carefully will break, this method, nevertheless, has many advantages ; and Andersson [1] recommends always to be supplied with a bottle of soluble glass when collecting in sand- and clay-deposits. If care be taken to let the preparations dry slowly, the result will often be surprisingly good.

At the places chosen for taking the samples of peat or similar soft deposits, vertical holes are dug to the desired depth, the cutting being trimmed with the sharp spade, care being taken not to disturb the succession of strata, or to get any recent plant fragments mixed into the mass. Careful notes of the freshly cut layers should be taken immediately, before the peat begins to darken through the influence of the air. Samples, 10 cc. in volume, should, in general, be taken at intervals of 50 cm. throughout the profile. Wherever any marked differences in the soil are observed, separate samples should be secured. The depth of every sample must be measured and noted on the labels and in the field book, as well as any observations regarding the consistency, color, odor, and other characteristics of the respective strata from which samples are taken. These samples are preserved either in jars or in clean canvas bags, and later examined in the laboratory.

The collector should also search for fossils on the spot. For this purpose the white plate is filled with water to the rim, and slices cut out from the stratum to be examined are carefully broken into pieces and washed, and any seeds or other remains removed with the brush and forceps, and preserved. This examination is facilitated if the peat is placed for some time in a diluted potassium or sodium lye, which must, however, be carefully washed away afterwards. Lagerheim's oxalic acid method, which will be described later, is still better for the purpose.

Series of samples are taken on different places of the bog, usually in a line across the deepest part of the formation so as to give a section of the basin, in which it has developed. The number of profiles to be opened depends naturally on the extent and topography of the formation, but from three to five profiles

---

[1] Andersson, G. Om senglaciala och postglaciala aflagringar i mellersta Norr-land. *Geol. fören. förh.*, vol. xvi, pt. 6. p. 550.

between the centrum and the shore are sufficient in most cases
for a bog of, say, 10 acres.

The collecting often has to be done under great difficulties on
account of the swampy character of the peat, which is often of
so loose a consistency, that it is impossible to open a hole to any
depth.   In this case an earth-auger or soil-sampler, has to be
employed.   Of these instruments there are many kinds in use.
One of the best for peat sampling purposes, that has come under
the observation of the writer, was described in 1894 by A. G.
Kellgren.[1]

His peat-auger consists of a steel pipe 1.5 m. in length and
about 4 cm. in diameter.   The
accompanying illustration (Fig. 1)
shows how the auger is arranged.
The lower end of the pipe is closed
with a piston which is pointed at
the apex, and can be lowered and
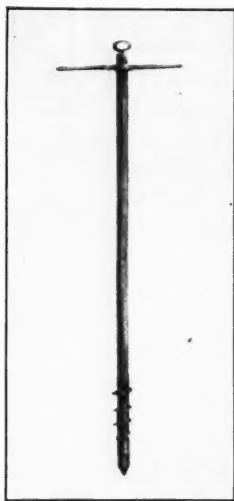raised in the pipe with a steel rod,
managed from the upper end.

If the sample to be taken is from
a compact peat, the auger is sunk
to the required depth, the piston is
drawn back into the pipe, and then
the auger lowered for about 10 cm.
The lower end of the pipe will thus
be filled with the earth which the
auger retains, when withdrawn.   In
order to secure the samples in a nat-
ural state, the first 10 cm. of pipe
at the end of the auger is split in
two halves, and these are secured

Fig. 1.— Peat-auger.

by hinges on one side, and fixed to the main stem of the pipe
with a screw arrangement which holds them together.   When
the sample has been obtained, this 10 cm. end of the pipe con-
taining it is unscrewed and opened, thus allowing the sample to
be removed intact.

[1] En ny konstruktion af mossborr.   *Geol. fören. förh.*, vol. xvi, pt. 4, pp. 372–
374.

When sampling is to be done in very loose or almost liquid sediments, the piston is pushed below the pipe, and when the end of this is filled with the mass, the piston is drawn back to its former position, which secures the sample.

The end of the pipe, which comes in contact with the sample should be kept scrupulously clean and free from rust. When the piston is withdrawn into the pipe, the cutting through the sediment, is, of course, done by the sides of the pipe as the auger is lowered. It is, therefore, essential that this part of the pipe be made of the best steel, so that the sides can be ground to a knife-edge and kept in that condition. The pitch of the screw must be low, and the boring should always be done very slowly. If samples are wanted from greater depths, the handle of the auger is shifted and new lengths of pipe and steel-rod are added.

The ulmic and humic substances, or those chemical compounds to which the peat owes its peculiar character, are developed in the presence of water and when dried are subject to molecular alterations, by reason of which they lose their ability to re-absorb water. There is no reagent known, as yet, that can restore to dry peat its original properties. The usual means employed in microscopy for causing swelling do not give satisfactory results. Experiments with lactic acid have also failed.

All collections from peat and other moist deposits have, therefore, to be kept in some preserving fluid, and must not be allowed to dry, because this would considerably increase the difficulties of determination, and in some cases even make identification impossible. With collections from fossiliferous clays and sand deposits this is not absolutely necessary, but desirable. Früh has shown through experiments that the ulmic and humic substances are immune for bacteria and fungi, and by reason of this they are almost completely absent from the peat-water, which can be used for some time as a preserving medium. Alcohol is generally employed, but samples of peat can be kept for years in a fresh state covered with the swamp-water in airtight vessels, if previously disinfected with carbon disulphide In case the samples have to be transported for some distance, the vessels containing them should be well filled with the preserving liquid so as to prevent unnecessary shaking.

Dried peat can to a certain degree be made suitable for examination, if boiled in water for three hours and afterwards saturated with 5 *per cent.* ammonia water for 48 hours. It should then be subjected to the same treatment as fresh peat, when prepared for examination. Fossil seeds and fruits, which have been allowed to dry, can be restored to their original shape and volume by the influence of a weak (2–3 *per cent.*) ammonia solution.

When peat has been under the influence of air for some time, it darkens, and the more this change of color proceeds, the more difficult will it be to find and determine the fossil remains. If the water contains iron in solution, as is often the case, the samples will, in a very short time, be almost black, which considerably lessens the possibility of a successful botanical examination.

In order to restore the original color to the fossils it is therefore necessary to let them undergo a bleaching process. This is effected in several ways. The oldest method, employed by Schröter[1] (1883), was to use Schultze's mixture for bleaching, as neither ammonia, potassium hydroxide, or calcium hypochlorite gave good results. This reagent certainly makes the dark-brown and opaque plant-remains from the peat transparent, so that nervation, cells, etc., can be studied, but usually acts too strong and often destroys the objects.

At present, Gunnar Andersson's nitric acid treatment is the method most used. According to this method the peat samples are put for 24–30 hours into commercial nitric acid diluted with twice as much water. In the phytogeographical laboratory of the University of Upsala, where the writer first studied telmatology under the guidance of Dr. Sernander, a solution of one part nitric acid (65 per cent.) and 3 parts water was used for macerating peat of loose texture, and one third acid when the samples were compact. From 12 to 16 hours treatment according to my experience, is sufficient in most cases for bleaching the peat, so that the fossils can be washed out.

The advantages of this method are certainly very great : all

---

[1] *Die Flora der Eiszeit.* Zürich, 1883, page 21.

clays, whether calcareous or not, disintegrate, and the samples of the usually tough and oily mass from the strata lying under the peat proper swell and are macerated. The dark color is bleached, the fossils are filled with gas-bubbles and float on the surface of the fluid, so that they can easily be collected.

But the method also has its drawbacks. Nitric acid of the strength required is liable to act with more or less damaging results on the organic tissues, and thus make the fossils more friable still than they were before. Certain minute microscopical remains are usually totally destroyed.

The process of bleaching should, of course, be done under a hood or similar device to get rid of the fumes of the acid. In case the examinations are done in the field one is confronted with the additional difficulties of transporting the acid.

Lagerheims's method of bleaching with oxalic acid is undoubtedly an improvement, because no injurious fumes are developed, the fossils are not affected, and the acid is in a solid form, and consequently easy to handle and transport. From the fact that oxalic acid is able to decolorize organic iron compounds Lagerheim concluded that it would be a good reagent for bleaching peat, especially when it contained iron in solution and had darkened in the air. Acting on this suggestion he found that pieces of peat immersed in a 3 *per cent.* solution of oxalic acid, almost instantly lose their dark color, which changes to brown. For the bleaching process a glass vessel is most suitable, and if this is exposed to daylight, or still better, to sunlight, the brown color fades gradually, until, after a few hours, the peat mass is ready for washing.

The influence of light is explained by the fact, already observed by Downes and Blunt (1879), that solutions of oxalic acid evolve carbon dioxide when exposed to the action of light. Other catalyzing agents are, for instance, salts of iron, which usually are present in peat. To the writer's knowledge the composition of these iron compounds that cause the dark coloring of peat has not yet been ascertained. Lagerheim is inclined to think that we have to do with some organic iron compound.

Peroxide of hydrogen is formed[1] in the process of oxidation

[1] Richardson, A.: The action of light on oxalic acid. *Proceedings Chem. Soc. London,* 1894, (137), 88.

of the oxalic acid solution, which probably takes place according to following reaction :

$C_2O_4H_2 + O_2 = 2CO_2 + H_2O_2$ and it is perhaps this peroxide of hydrogen that, in combination with some other compounds,[1] effects the bleaching.

According to Richardson, the total amount of hydrogen peroxide formed in the solution increases with the concentration of the acid, while at the same time the proportion of peroxide to acid formed decomposed decreases simultaneously, and since the described action of the head occurs with greater rapidity if considerably diluted, only a very weak solution should be used.

If the fossils, especially leaves, are wanted almost colorless, the following method of bleaching is recommended. A solution (not too strong) of potassium permanganate, is employed where they are allowed to lie for some time, and then transferred directly into the oxalic acid solution.

To extricate fossils from calcareous peat it is necessary to remove the carbonate of lime, and this is best done with hydrochloric acid. If, however, the material contains lime in a small degree only, application of the acid will result in effervescence, which causes the decomposition and penetration to take place very slowly and unevenly. In order to prevent this, the peat-particles are thoroughly saturated with strong alcohol, and the hydrochloric acid is applied afterwards. The separation will now proceed easily and uniformly, and the gas-bubbles are bursting so soon, that no undesirable foaming is caused. Should this occur, the mass is again treated with alcohol. The separated peat-material can then be preserved in the alcoholic calcium-chloride liquid.

Whatever method is employed for bleaching, this process has to be done very carefully, so as to prevent the fossils from being destroyed by the acids. The next step is the "slumming," or washing of the macerated mass. For this purpose there are different devices for slumming vessels. These are all constructed on the plan of creating a rising current of water through the mass, which is poured over a sieve of brass netting with meshes not smaller than 1.5 mm. in diameter.

---

[1] Hydrogen peroxide alone does not bleach peat.

A good arrangement is to have a porcelain vessel fitted with two sieves, the upper one with meshes of about 2 mm. and the lower 1.5 mm. The sieves are placed about 5 cm. apart, and two currents of water, the velocity of which can be regulated by cocks, should be used, one under each net. Figure 2 shows a contrivance made on these principles and used by the writer with good success. The residue of the slumming need not be examined, if portions of the sample have been reserved for microscopic examinations for spores, pollen, algæ, bryozoa, molluscs, rhizopods, cirripeds and other Crustacea, fragments of echino-derms and insects, and other minute animal remains. In order to get a more complete collection of these fossils the slumming water, which, of course, has previously been examined and found free from diatoms, should be allowed to pass through a silk net as shown in Fig. 2.

The slumming is comparatively easy if the material is somewhat sandy, but when sticky or miry, the

FIG. 2.— Slumming vessel.

mass has to be stirred and sometimes broken by the hands of the operator.

With regard to the slumming and preparation of clays for the study of diatoms or for mechanical analysis, the technical details have so often been described that we need not go into them here.

When the fossils are ready for preservation twigs, pieces of bark and wood, cones, nuts, rhizomes of grasses, and other larger fossils are usually kept in 40 *per cent.* alcohol or in a 1–2 *per cent.* solution of formalin. Seeds and fruits are preserved in
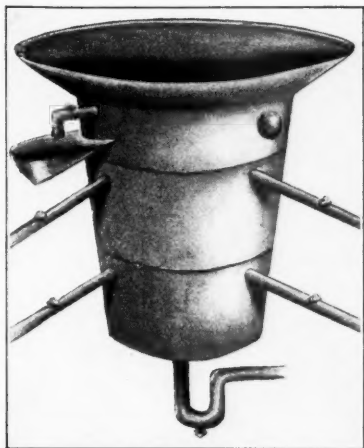
alcohol or in sterilized water.   In the latter case, the glass tubes are immediately sealed with melted paraffin, which acts both as a cork and as an isolating medium.   Larger leaves are best preserved in a mixture of 2 parts of glycerine, 1 part carbolic acid, and 7 parts water.   Remains of delicate mosses and small leaves, parasitic fungi, and algæ should be preserved in Canada balsam like ordinary microscopic preparations.

Andersson recommends another plan of preserving, which has its advantages.   After being dehydrated in alcohol, the fossils are transferred to a 30 *per cent.* solution of benzin-alcohol, thence to a 70 *per cent.* solution, afterwards, to pure benzin, and subsequently to a saturated solution of naphthalin in benzin. The fossils are kept here for some time, until the fluid has well penetrated.   When the objects are drying the benzin evaporates, and the surface is covered with small crystals of naphthalin. These gradually evaporate and the object will remain almost entirely unaltered.   No shriveling is observed, and the contraction is estimated to be only 1 *per cent.*   This treatment can be employed well for preserving larger objects.

When examining and mounting minute and fragile fossils, it will be found convenient to do the bleaching on the object-slide. The material is then washed in water in order to remove all the acid, and afterwards placed in alcohol until all gas-bubbles have disappeared.   The washing should be repeated in absolute alcohol, and when the objects are thoroughly dehydrated they are transferred to a mixture of equal parts of xylol (or toluol) and absolute alcohol, subsequently to pure alcohol for a moment, and by this time they are ready for mounting in Canada balsam.

The fossils are usually rather brittle, so that when sections are wanted the razor and freehand cutting will be found unsatisfactory and imbedding in paraffin and the microtome have to be employed as for histological work.

For an exhaustive investigation, the statistical method will be useful to follow, and from the proposed size of samples 10 cc., a fair idea can be obtained of the quantity of fossils in a certain stratum.

To get a clear conception of the history of the vegetation of a place, it is not, however, sufficient to examine the fossils in the

deposits. The topography of the neighborhood has to be carefully studied, and the existing vegetation investigated, especially with regard to composition and relation of the various plant-communities. But also ecological conditions have to be observed in this connection, because in some cases they are of considerable help in interpreting the successive evolutional phases of the vegetation.

Leland Stanford Jr. University,
Department of Systematic Botany.
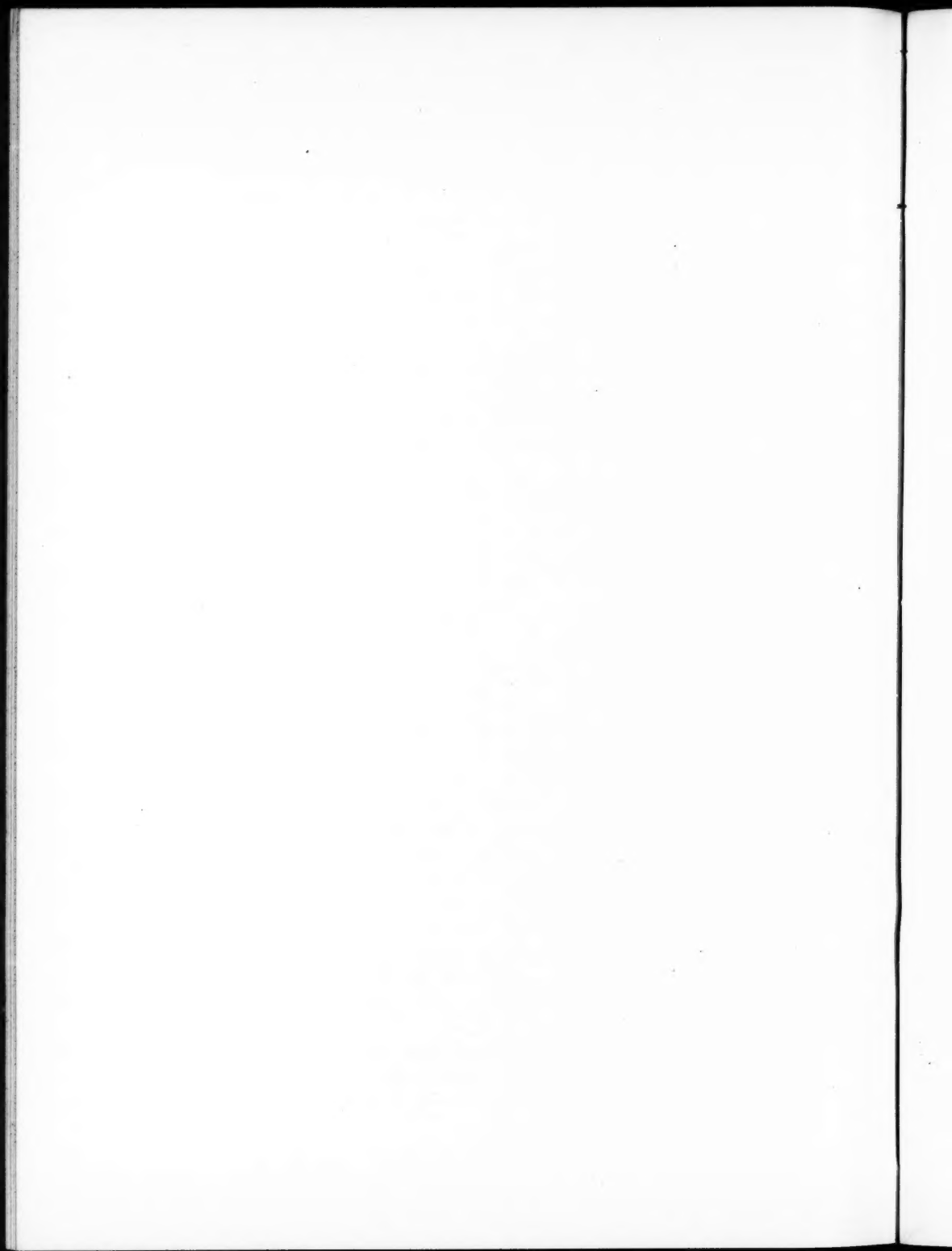
NOTES AND LITERATURE.

EXPLORATION.

Hatcher's Narrative of the Princeton Patagonia Expedition.
— In a quarto of twelve chapters,[1] illustrated by fifty large heliotype plates and a map, Mr. Hatcher gives an account of three expeditions to Patagonia after fossil vertebrates, adding at the end a chapter on the geography of the region.

This is by far the best description of travel in Patagonia that has been written. Mr. Hatcher's observations are keen and accurate, while his judgment is expressed in a fair manner, based on notes made during a period of three years experience, in which time they have been corrected and verified. The matter is of such absorbing interest that one's attention is held throughout. Here we see the trained naturalist at work, and gain some idea of the hardships and difficulties entailed and the joys experienced in exploring a comparatively unknown land.

There are many well-noted observations on the physical features of the country, animal and vegetable life, geology, etc., which make this book a compendium of interesting information regarding the little known land of Patagonia. The heliotypes in several instances do not clearly represent the subject illustrated, and it seems possible that another method of reproduction might have been used to advantage.

In the chapter entitled "Geography" the author treats the great physical divisions of the surface, describes the rivers, indicates the origin of the numerous lakes by pointing out their relation to the present inland waters of the channels, and reasons out in a convincing manner the changes through which this part of the continent has passed from the earliest times. The different tribes of Indians, their habits and mode of life are accurately described. The last chapter is on the resources of the country.

In speaking of lizards, p. 84, Mr. Hatcher says: ".... over the pampas, a great variety of small lizards of varying size, shape and color, but no snakes." This observation on lizards should have

[1] Reports of the Princeton University Expeditions to Patagonia, 1896–1899. Vol. i. Narrative of the Expeditions Geography of Southern Patagonia. Princeton, The University, 1903. 4to. xvi–314 pp., 51 pls., map.

been confined to that part of Patagonia north of the Rio Santa Cruz, for this river forms the natural southern boundary line for lizards as well as of armadillos though a few have been scattered south of it by man. In describing the Guanaco on page 271, he says: "Their presence in Fuego, to which island the rhea, puma and deer have not gained access, is but an illustration of their superior powers of self distribution." The distribution of guanaco on Tierra del Fuego is far more probably attributable to the agency of man, for since time immemorial the channel Indians have plied between Patagonia and Fuego in their canoes and might easily have introduced these animals.

BARNUM BROWN.

ZOÖLOGY.

A Summary of the Coccidæ.[1] — The new "*Catalogue of the Coccidæ of the World*" by Mrs. M. E. Fernald, just published by the Massachusetts Agricultural Experiment Station, will be of immense value to students of these insects. For the first time since Signoret's "Essai" appeared, nearly thirty years ago, the species are catalogued with full bibliographical references. The preparation of the work has been a tremendous task, involving a search through the scattered literature published in every part of the world, and in all sorts of languages. There are few places where it could have been attempted, and few people who would have had the courage and perseverance to carry it out.

In the catalogue, 1449 species of Coccidæ are recognized as valid. The time since 1758, when the tenth edition of the "Systema Naturæ" appeared, may, so far as the Coccidæ are concerned, be divided into four periods. The first is from 1758 to 1799, during which 38 species were described. The second, from 1800 to 1850, saw the description of 57 valid species. The third, in which scientific coccidology really began, culminated in Signoret's famous work which covered the whole subject as then understood. In this period,

---

[1] Fernald, Maria E. A Catalogue of the Coccidæ of the World. Special *Bulletin Mass. Agr. Exp. Sta.* No. 88, pp. 360.

from 1850 to 1875, 145 species now held valid were published. At
the end of the period, only 240 species were known, as against 1449
in 1903. The last period, from 1876 to 1903, saw the publication of
no less than 1209 species, and no doubt the next will make known a
far larger number. The beginning of the fourth period was coinci-
dent with the first labors of Maskell of New Zealand, whose writings
extended over many years, and made known the rich coccid-faunæ
of New Zealand and Australia, treating also of a good many species
from other regions. To-day, the workers are more numerous than
ever before, but still not sufficiently so to deal with the material
which might readily be obtained. The coccid-faunæ of Cuba and
the Philippines, for example, are practically unknown, though there
is no doubt that they are rich and interesting.

The genera recognized in the list number 168, distributed in sub-
families as follows : — Diaspinæ, 34 ; Coccinæ, 57 ; Tachardiinæ, 2 ;
Dactylopiinæ, 54 ; Conchaspinæ, 1 ; Phenacoleachiinæ, 1 ; Orthe-
ziinæ, 3 ; Margarodinæ, 5 ; Monophlebinæ, 11. I have thought it
worth while to prepare the following summary, in which the genera
are all listed according to their distribution, the number of species
being given after each generic name. In doing this, I have made
use of my own knowledge of the introduction of species into localities
by human means, and of the fact of certain localities being errone-
ously cited. The purpose has been to throw light on the natural
distribution of the genera.

(1.) Genera which are cosmopolitan or nearly so.

Palæococcus, 11.	Asterolecanium, 27.	Eriococcus, 60.
Icerya, 16.	Lecaniodiaspis, 17.	Phenacoccus, 36.
Coccus, 29.	Pulvinaria, 60.	Pseudococcus, 100.
Chionaspis, 59.	Aspidiotus, 77.	Lepidosaphes, 62.

Some of these, such as Aspidiotus, Coccus and Chionaspis, are
assemblages of more or less discordant elements, and will no doubt
eventually be subdivided. On the other hand, the species of Lecani-
odiaspis, Asterolecanium and Eriococcus are certainly closely allied ;
and in Lecaniodiaspis there are undoubtedly native species in South
Africa, Arizona and Japan, which are as nearly alike as they could
very well be without being the same. When we consider the limited
means of travel possessed by the Coccidæ, and the long period which
must have elapsed during this wide migration, the persistence of type
is something remarkable. The monophlebid genera Icerya and Pa-
læococcus show the same sort of thing ; and it is noteworthy that

Palæococcus is one of the few genera found fossil. Icerya is wanting in the colder parts of the Palæarctic and nearctic regions, being essentially a tropical and subtropical type.

(2.) Genera which are very widely distributed, but not cosmopolitan.

Margarodes, 10. Europe, Africa, America.

Orthezia, 19. Palæarctic, Nearctic, Neotropical.

Rhizococcus, 14. Europe, New Zealand, Australia, Texas; but the species may not be strictly congeneric.

Sphærococcus, 19. Australia, Japan, North America. The species may not be truly congeneric.

Ceroputo, 7. Europe; North America, extending into the Neotropical region.

Ripersia, 37. Holarctic, New Zealand, Australia, and doubtfully congeneric species in India and Trinidad.

Tachardia, 24. Cosmotropical.

Lichtensia, 12. Holarctic and Neotropical, but mainly the latter, if the species are really congeneric.

Ceroplastes, 62. Very abundant in the Neotropical region, extending into the warmer parts of the United States; Mediterranean region to South Africa; a few species in Asia and Australia, those in the latter country probably introduced.

Saissetia, 20. Cosmotropical.

Phenacaspis, 15. North America, Asia, S. Africa, Australia.

Chrysomphalus, 31. America, Australia, Asia. Numerous in Mexico.

Targionia, 18. Holarctic, Australia, India.

The doubt expressed as to the species of certain genera properly belonging together rests on the fact that the generic characters seem more or less artificial or arbitrary, and may include species which have independently come to have certain peculiarities. Thus, Rhizococcus is essentially an Eriococcus without a sac; but we do not know that the sac might not be independently lost in different parts of the world. The only way to settle these matters is by the study of all stages and both sexes of numerous species.

(3.) Genera having few species very widely separated.

Tessarobelus, 2. One in New Caledonia, one Panama. Probably they are not strictly congeneric.

Llaveia, 7. Neotropical except one from the East Indies, which may not be properly referred here.

Stigmacoccus, one in Brazil, one in India.

Ortheziola, 3. Two European; one in West Indies, but I suspect introduced.

Conchaspis, 3. Neotropical and Ceylon. No doubt spread by man.

Cerococcus, three North American, one in India.

Solenophora, 9. North and South America and New Zealand, in each case doubtless native.

Gossyparia, 5. Australia, New Zealand, Europe. Perhaps not all congeneric.

Erium, 7. Australia and America.

Rhizæcus, 4. Europe; one in West Indies, perhaps introduced.

Ripersiella, 4. Three in North America, one in New Zealand.

Takahashia, one in Mexico, one in Japan.

Protopulvinaria, one Neotropical, and Mr. Green has an undescribed one in Ceylon. I suspect that the Neotropical one was introduced from Asia.

Mallococcus, one in Brazil, one in China.

Ctenochiton, 15. New Zealand, Australia, and one in Mexico.

Cardiococcus, two in Australia, one in Mexico.

Inglisia, 8. New Zealand, Asia, Neotropical.

Ceroplastodes, 5. North America, Australia, Asia.

Akermes, 9. . Neotropical and Australia. Some are probably not congeneric.

Paralecanium, 7. Australia, Asia, one in Brazil.

Diaspis, 30. America, and several Old World species which may not be strictly congeneric.

Poliaspis, 8. Australia, S. Africa, Japan.

Leucaspis, 8. Europe, Australia, Japan, Western America. The species are not all congeneric.

Cryptophyllaspis, 4. One in the United States, one in Ceylon, one in the Bismarck Archipelago, and one (accidentally omitted from the list) in Madeira. I think that these are probably not all really congeneric.

Odonaspis, 5. Tropical Asia; one in Brazil, surely introduced, I think.

Gymnaspis, 3. Asia, Australia and the Neotropical region; I believe introduced in the latter.

Some of the above cases should afford satisfaction to believers in

Antarctica.   It is to be remarked, however, that some of them may appear in different light when we know more of the Coccidæ of tropical Asia.   Nevertheless, it is hard not to think Ripersiella, Akermes, Ctenochiton etc. significant of some southern route.

(4.)   Holarctic Genera.

I use the term Holarctic as a convenience, but do not mean thereby to abandon the Nearctic and Palæarctic as separate regions.

Xylococcus, 3.

Kermes, 28.   On oaks.   A species described from Australia can hardly be congeneric.

Trionymus, 2.	Exæretopus, 2.
Antonina, 7 (also China).	Eriopeltis, 3.
Eulecanium, 71 (one in Brazil).	Physokermes, 3.
Lecanopsis, 3.	Aclerda, 7 (and Natal, one species doubtfully congeneric).

(5.)   Nearctic Genera.

Olliffiella, 1 (making a gall on oak).	Gymnococcus, 3.
Pseudophilippia, 1 (Florida).	Philephedra, 1 (New Mexico).
Toumeyella, 6.	Comstockiella, 1 (on palms).
Pseudodiaspis, 2 (one in Mexico).	

These are all southern genera, from the very borders of the Neotropical, or evidently derived therefrom.   There is no characteristic Nearctic genus, generally distributed throughout that region, and not found elsewhere.

(6.)   Neotropical Genera.

Porococcus, 2 (Mexico).	Dactylopius, 3 (one entering Nearctic).
Tectococcus, 1.	Carpochloroides, 1.
Apiococcus, 4.	Capulinia, 3.
Cryptokermes, 1.	Termitococcus, 2.
Pulvinella, 1.	Tectopulvinaria, 1.
Alichtensia, 1.	Edwallia, 1.
Platinglisia, 1.	Schizochlamidia, 1.
Pseudokermes, 2.	Eucalymnatus, 4 (one may be native in Asia).
Stictolecanium, 1.	
Mesolecanium, 12 (enters Sonoran).	Megasaissetia, 1.
Neolecanium, 12 (enters Nearctic).	Platysaissetia, 1.
Protodiaspis, 1.	Xanthophthalma, 1.

Pinnaspis, 2 (also Old World, whence
    probably introduced).
Pseudischnaspis, 3.
Diaspidistis, 1.

Morganella, 2 (widespread
    by human means).
Pseudoparlatoria, 4.

It will be noticed that many of these are monotypic; representing, no doubt, particular excessively differentiated types, not illustrative of any general tendency. Pinnaspis is so like the Old World Hemichionaspis that I feel nearly sure that it is introduced into America. One of its species is now widespread in both hemispheres.

(7.) New Zealand Genera.

Cœlostomidia, 5.
Eriochiton, 3 (one from India).

·Phenacoleachia, 1.
Lecanochiton, 2.

Three of these appear to be genuinely isolated and very peculiar types.

(8.) Australian Genera.

Monophlebulus, 1.
Callipappus, 6.
Antecerococcus, 2.
Birchippia, 1.
Cylindrococcus, 4.
Sphærococcopsis, 1.
Epicoccus, 1.
Pseudoripersia, 1.
Myxolecanium 1 (New Guinea).
Alecanopsis, 1.

Frenchia, 2.
Apiomorpha, 34.
Opisthoscelis, 12.
Ascelis, 5.
Olliffia, 1.
Ourococcus, 3.
Lachnodius, 3.
Austrolichtensia, 1.
Cryptes, 1.
Maskellia, 1.

Here we have a genuinely peculiar fauna, the gall making genera being especially remarkable. Maskellia is the only Diaspine genus in the list, it will be noted, whereas the neotropical list includes seven genera of this group.

(9.) Genera of tropical Asia.

Monophlebus, 9 (three species, doubtfully congeneric, are African).
Drosicha, 6 (also Australasia).
Walkeriana, 7 (also African).
Kuwania, 2 (one in Japan).
Chætococcus, 1.
Ceronema, 3 (Australia to Japan).
Ericerus, 1.
Howardia, 1 (original locality uncertain).

Anomalococcus, 1.
Amorphococcus, 1.
Geococcus, 1.
Kermicus, 1.
Pseudopulvinaria, 1.
Vinsonia, 1.

Hemichionaspis, 10 (also Africa, etc).

Fiorinia, 25 (extended to Australia and New Zealand).

Pseudaonidia, 6 (also African).   Aonidia, 12 (one is Palæarctic).

Greeniella, 1.   Ischnaspis, 1 (origin uncertain).

It will be noticed that the faunæ of tropical Asia and Africa have elements in common, as might have been expected.

(10.)   Genera of tropical Africa.

Lophococcus, 1.   Cissococcus, 1.

Halimococcus, 1 (also tropical Asia, undescribed species in Mr. Green's possession).

Tylococcus, 1 (Madagascar).   Lagosinia, 1.

Gascardia, 1 (Madagascar).   Cryptinglisia, 1.

Stictococcus, 1.   Selenaspidus, 1 (origin uncertain).

Some of these are very remarkable. The Coccid fauna of Africa is as yet very little known, and it doubtless contains many wonderful things.

(11.)   Palæarctic genera.

Gueriniella, 1.   Pollinia. 2 (one is S. African.)

Newsteadia, 1.   Nidularia, 1.

Phœnicococcus, 1 (Algeria, an offshoot from the Ethiopian fauna).

Puto, 1.   Tetrura, 1.

Fonscolombia, 2.   Cryptococcus, 1.

Kuwanina, 1 (Japan).   Spermococcus, 1.

Luzulaspis, 1.   Filippia, 1.

Chelonicoccus, 1 (doubtful genus). Parafairmairia, 1.

Aulacaspis, 6 (extends to tropical Asia, etc.).

Parlatoria, 17 (extends to tropical Asia, etc.).

Syngenaspis, 1.

Epidiaspis, 1.

It would seem that Europe has more peculiar types than North America.

<div align="right">T. D. A. Cockerell.</div>

Another Text-book of Entomology.[1]— "To induce the student to become acquainted, through personal observations in the field and laboratory, with some of the important biological problems as pre-

---

[1] Hunter, S. J. *Elementary Studies in Insect Life.* Topeka, Kan. Crane and Co., 1903. 12mo, xviii + 344 pp., 234 figs.

sented by insects," is stated to be the object of this book. It aims to present a course in study of insects, prepared from the biological point of view. Hence, the opening chapters deal with such general themes as metamorphosis, senses and sense organs, coloration, social life, habits and instincts, and the relations between flowers and insects. Discussion of these themes occupies 119 pages. Then follows a chapter of 43 pages on economic entomology pure and simple, and another of 39 pages on systematic entomology. In the latter the orders are briefly discussed, with scant reference to either their metamorphoses or other biologically interesting characteristics. Another brief and heterogeneous chapter of 20 pages discusses geographic distribution, the struggle for existence, parasitism, natural selection etc. As an academic discussion of the biology of insects this part is singularly lacking in unity and coherence.

Part II is devoted to methods, equipment and laboratory exercises. There are outlines for practical study of but two of the biological themes discussed in part I : metamorphosis, and the habits of ants. For the balance, there is but another outline for the study of grasshopper anatomy, and another key to the orders and principal families of insects. There are many illustrations — far too many in fact in the laboratory outline, wherein each part is figured for the student ; and while they appear to have been made from good originals, they are not well reproduced, and too often appear inky.

In so far as the study of the biological aspects of insect life is concerned the profession is better than the performance. There is considerable rambling discussion of biological themes (and this appears to be all that is offered as new in the method of the book) but, with the two exceptions noted above, there is no program set before the student for the study of them. The lapse into anatomy and the making of systematic determinations for the student's training is the more regrettable because there were many better laboratory outlines for grasshopper dissection, and a few better keys, already in existence. It may be, however, that the thin strata of insect biology, anatomy, collection making, systematic determination and economic procedure brought within the covers of a single book will afford light digging for short course students.

The chief criticism of it as a laboratory book is that it is pedagogically weakest in those matters on which it lays greatest stress. In this respect it is much like some other modern books of botany and zoölogy, which introduce ecological and biological phenomena, and get no farther than mere academic discussion of them. This endan-

gers a relapse to text book methods, and neglect of the first hand
study of the facts.   Is it too much to expect of teachers who empha-
size the value of these subjects that they should guide the students
in the gathering, correlating and interpreting of biological data by
definite and practical methods that will insure the least waste of
time and energy? Shall we never get rid of the spectacle of a
teacher and a score of students trying to peer at once into the same
worm hole? Shall we be forever content with merely *demonstrating*
biological phenomena?

<div align="right">J. G. N.</div>

Two Papers on Insect Wings.[1] — A remarkable American silk-
worm moth (*Telea polyphemus*) with its right wings deviating from
the normal in both color pattern and venation, furnishes to Dr. G.
Enderlein a theme for the discussion of ontogenetic processes.
The important part of the paper is that embodying the results of a
search for ontogenetic processes in the light of which the aberration
might be explained.   These remarks from the introduction are inter-
esting and set forth the author's point of view: "Experimental
investigations serve only as a means of varying ontogenetic processes
and also, therefore, of influencing, hindering or varying the com-
bined sum of inner mechanical forces by means of the outer mechan-
ical forces, in order to advance a little by means of the knowledge
of their reaction to these forces.   By such means no new forms will
be brought to light ; for no noteworthy, sudden result can be induced
in phylogeny by the operation of external influences : phylogeny is
but the slowly progressing result of summarization ; so we would
have to expect only phylogenetic forms which still exist somewhere
in ontogeny.   Retarded developments (*Hemmungsbildungen*), which
we may designate as reversions, are of equivalent value, whether we
think of the anlage in the egg or of a later outcome of ontogenetic
processes.   But it should not be understood that all reversions have
existed as actual species, for there may be manifold combinations of
phylogenetically younger and older component factors."

So the author sets about a very careful investigation of the struc-
ture of Saturnian and other Lepidopterous pupæ.   Incidentally he
makes some contributions to the knowledge of the nervous system

---

[1] Enderlein, G.   Eine einseitige Hemmungsbildung bei Telea polyphemus vom
ontogenetischen Standpunkt : ein beitrag zur Kenntniss der Entwickelung der
Schmetterlinge.   *Zool. Jahrb.*, Abt. für Anat. u. Ontogenie der Thiere.   Vol. 16,
1902, pp. 44. 3 pls.

and digestive and reproductive organs, but his main purpose and his best results are in the study of the pupal tracheal system, and in the relation of the same to the venation of the adult wing. Most of his conclusions are abundantly evidenced, though some of them are not entirely new : but one of them at least — his two systems of tracheæ and veins, radial and median — is of very doubtful value : it rests on altogether insufficient evidence. Lepidoptera alone with their single pair of longitudinal tracheæ trunks, are too highly specialized to show what was the primitive manner of grouping. In the light of facts presented by other more generalized orders — facts that are set forth in a paper that the author repeatedly cites [1] — such grouping seems little less arbitrary than that of Spuler (into "spreitentheil" and "faltentheil") which Dr. Enderlein justly condemns.

He finds in the end that his aberrant moth represents in the configuration of its venation from the ontogenetic point of view a pupal stage preserved in adult life : from the phylogenetic point of view, a one-sided reversion to a phylogenetically earlier stage, that is now normal to no living Saturnian moth.

The second and more recent paper is by Tower,[2] who makes a large and timely contribution to the knowledge of the development of the wings in Coleoptera. He calls attention to the great diversity of larval form and habitat and habits, and tabulates the differences in number of larval stages, length of larval life and time of first appearance of larval wings, and then discusses in detail the three types of early wing formation he finds in the order. His "simple type," which he finds to be "the dominant type of wing development in beetles" is most interesting, because it bridges the gap in type of wing development between the holo- and the hetero-metabola. During the last larval stage the wing is directly evaginated downward underneath the cuticle and is merely uncovered by the last moult. His "recessed type" in which the wing rudiment withdraws slightly from the surface to the bottom of a hypodermal pocket, as in Corethra, and his "enclosed type," in which the wing withdraws and is shut in by the closure of the pocket, as in Lepidoptera generally, are in beetles much less common.

He concludes that "the wings and spiracles arise in homologous

[1] Comstock and Needham, The wings of Insects. *Amer. Nat.*, vols. 32 and 33, 124 pp.

[2] Tower, W. L. The origin and development of the wings in Coleoptera. *Zool. Jahrb.* Abt. für Anat. u. Ontogeny der Thiere. Vol. 17, 1903, pp. 516–572, Pls. 14–20.

positions on the sides of the segments, as determined by the position of homodynamous muscles, and that the hind wings are derived without much doubt from the degenerate spiracle disc of the metathorax ": and adds, " All the evidence here presented concerning the wings of Coleoptera and Hetermometabola is most positively opposed to the theory of the origin of the wings of insects as dorsal backward prolongations of the tergum."

There is little new ground broken in this paper, but there is much more careful tillage of a hitherto indifferently cultivated field.

J. G. N.

BOTANY.

A New Flora of the Southeastern United States.[1] — A new handbook of the flora of this region has long been a desideratum, the data concerning the southern states being confined to antiquated books, the latest of which, Chapman's *Flora*, is a decade old, and to scattered descriptions, collector's notes, and isolated specimens, chiefly in the larger herbaria,— apart from one of which they could hardly have been brought together satisfactorily. Dr. Small, who is curator of the museums and herbarium of the New York Botanical Garden, and who has personally made extensive trips over a considerable part of the territory covered by the new Flora, consulting Elliott's herbarium at Charleston and the original Chapman herbarium at the New York Garden, is in an unequaled position to undertake the preparation of such a handbook, and though his own experience in the several years during which it has been going through the press shows the rapidity with which such works call for change when once launched, he has succeeded in placing before the public a manual which, if of awkward form and size for field use, is indispensable to every herbarium and botanical library in which the North American flora receives attention.

[1] Small, J. K., *Flora of the Southeastern United States being descriptions of the Seed-plants, ferns, and fern-allies growing naturally in North Carolina, South Carolina, Georgia, Florida, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, and the Indian Territory and in Oklahoma and Texas east of the One hundredth meridian.* New York, published by the author, 1903. 8vo, xii + 1370 pp.

In all respects the treatment of the subject is modern.   The phylogenetic arrangement of Engler and Prantl is essentially adopted; the Neo-American practice in nomenclature is followed as consistently as it is likely to be followed,—familiar generic names being added as synonyms when discarded under this practice; and genera and species have been subjected to the prevalent minute segregation.   Opinions may and do differ greatly as to the desirability of some of these practices, and in the last-named respect Dr. Small is scarcely surpassed by any living botanist on this side of the ocean : but by what appear to be well-made keys and terse contrasted descriptions he makes reasonably clear his idea of the species that he names,— 6364 in number, grouped under 1494 genera, pertaining to 236 families, of 62 orders.

<div align="right">T.</div>

Notes.— An unusually satisfactory series of plates showing autumnal coloration of foliage is contained in a paper on " Tree planting on Streets and Highways," by W. F. Fox, published at Albany, by the Forest, Fish and Game Commission of New York.

A capital treatise on woody plants in winter, illustrated by numerous habit, bark and detail figures, by Schneider, has been issued from the press of Gustav Fischer, Jena, under the title *Dendrologische Winterstudien.*

An account of the characteristics of some southern trees, by Emma G. Cummings, is contained in Part I of the *Transactions of the Massachusetts Horticultural Society* for 1903.

"A Primer of Forestry," by Pinchot, is published as *Farmers' Bulletin* No. 173 of the *Departme t of Agriculture.*

The value of oak leaves for forage is discussed by Mackie in *Bulletin* No. 150 of the *Agricultural Experiment Station of the University of California.*

A series of practical little Bulletins, somewhat comparable with those issued by the Experiment Stations in this country, is being distributed by the Biologische Abtheilung für Land- und Forstwirthschaft, of the *Kaiserliches Gesundheitsamt,* of Berlin, under the title " Flügblätter."

The forage conditions and problems of Eastern Washington, Eastern Oregon, Northeastern California and Northwestern Nevada are

discussed by Griffiths in *Bulletin* 38 of the *Bureau of Plant Industry of the United States Department of Agriculture.*

The *Yearbook of the United States Department of Agriculture*, for 1902, recently issued, contains the usual variety of papers, primarily of economic interest but a number of them botanically valuable.

"Loco and other poisonous plants of Montana" are discussed by Blankinship in *Bulletin* No. 45 of the *Montana Agricultural Experiment Station.*

The cultivation of sisal in Hawaii is the subject of a paper by Conter, published, with illustrations, as *Bulletin* No. 4 of the *Hawaii Agricultural Experiment Station.*

A very attractively gotten-up account of Luther Burbank and his work in horticulture, by Wickson, has been reprinted from the *Sunset Magazine* by the Southern Pacific Company of San Francisco.

The new ideals in the improvement of plants are discussed by Bailey in an illustrated article in *Country Life in America* for July.

A comparison of hybrids with their parent forms, by de Vries, is published in the *Revue Générale de Botanique*, of June 15.

An article on plants as a factor in home adornment, by Corbett, is reprinted from the *Yearbook of the Department of Agriculture* for 1902.

No accounts of school gardens, published in this country, are more interesting or better illustrated than those contained in current volumes of the *Transactions of the Massachusetts Horticultural Society.*

Dr. Grout, who a few years since wrote a little guide to the study of mosses with the aid of a hand-lens only, has issued the first part of a well printed and nicely illustrated book of larger scope under the title *Mosses with Hand-Lens and Microscope.* His purpose is to present a handbook of the more common mosses of the Northeastern United States with the avoidance of unnecessary technicalities.

A new list of the "Pteridophytes of Iowa," by Lyon, reprinted on July 3rd from *Minnesota Botanical Studies*, contains the interesting information that gametophytes of *Botrychium obliquum* and *B. virginianum* have been collected in that State, both species at Echo Lake, and the last named also at Grand Marais.

As Part 3 of the current volume of *Contributions from the United*

States National Herbarium, Mr. Maxon publishes a study of certain Mexican and Guatemalan species of Polypodium.

A monograph of the Belgian species of Cladonia, by Agriet, constitutes the third fascicle of Volume 40 of the *Bulletin de la Société Royale de Botanique de Belgique*, for the year 1901, issued in June 1903.

The bitter rot of Apples forms the subject of a paper by von Schrenk and Spaulding, published as *Bulletin* 44 of the *Bureau of Plant Industry* of the Department of Agriculture. The fungus commonly known as *Gloeosporium fructigenum*, but in one of its forms first named *Septoria rufo-maculans* by Berkeley, is here named *Glomerella rufomaculans*, the genus standing practically for Gnomoniopsis of Stoneman, but not of Berlese.

Diseases of the apple, pear, and quince are discussed in *Bulletin* 183 of the *North Carolina Agricultural Experiment Station*.

The *Journal of the Royal Horticultural Society* for April, as is usual with that journal, contains a good many botanically interesting matters, among others a continuation of Cooke's "Fungoid pests of the garden."

Two new diseases of the raspberry, cane blight and yellows, are discussed in *Popular Bulletin* no. 226 of the *New York Agricultural Experiment Station*, issued last December but dated December 1903.

Like preceding numbers, Professor Peck's Report of the State Botanist for 1902, published as *Bulletin* 286 of the University of the State of New York and issued in May, contains descriptions and figures of a considerable number of pileate fungi.

A helpful feature of the *Ohio Mycological Bulletin* consists in the printing of accent marks over generic and specific names, — but unfortunately the popular rather than the correct accentuation is occasionally given.

A phalloid (probably *Ithyphallus celebicus*) is described by Fischer in *Mededeelingen van het Proefstation Oost-Java*, III, No. 46, as living in close symbiosis or scarcely injurious parasitism on the roots of the sugar cane, in Java.

Monascus purpureus and its systematic position, are considered, by Ikeno, in the *Berichte der Deutschen Botanischen Gesellschaft* of June 24.

In the *Proceedings of the Academy of Natural Sciences of Philadelphia*, LV, Part I, Keeley gives directions for the preparation of Diatoms for microscopical examination of their structure.

The American Botanist for June contains the following articles, all popular : — Bradshaw, "Poppies"; Stillman, "A climbing Fern"; Barrett, "Odd Odors"; Dallas, "Hints for Beginners in the Study of Mushrooms"; [Clute], "Botany for Beginners — III"; Field, "New Jersey Tea"; and. Goetting, "Children's Names for Flowers."

The Atlantic Slope Naturalist, a new, popular, little journal, contains in the July–August number a short note by Bessey on the "Distribution of Forest Trees on the Nebraska Plains," and a note by Rotzell on "The Smoking of Red-Willow Bark by the American Aborigines."

The botanical *Bihang till Kongl. Svenska Vetenskaps-Akademiens Handlingar*, Volume 28, recently published, contains a number of important papers in various fields of botany.

The *Bryologist* for. July contains the following articles : — Harris, "Lichens — Sticta"; E. G. Britton, "West Indian Mosses in Florida"; Renauld, "*Hypnum capillifolium Baileyi*"; Williams, "Additional Mosses of the Upper Yukon River"; Grout, "The Peristome, V"; and a continuation of reprints of Cardot and Thériot's "Mosses of Alaska" from the *Proceedings of the Washington Academy of Sciences.*

The *Bulletin of the Southern California Academy of Sciences* for April–May contains the following botanical articles : Abrams, "New Southern California Plants"; Davidson, "New plant records for Los Angeles County, — II.; Hasse, "Additions to the Lichen-Flora of Southern California"; Hasse, The Lichen-flora of San Clemente Island"; and Hasse, "Additions to the Lichen-flora of Southern California, — II."

The *Bulletin of the Southern California Academy of Sciences* for June contains the following botanical articles : — Heller, "Notes on Plants from Middle Western California"; Davidson, "New Plant Records for Los Angeles County, — III."; and Hasse, "Additions to the Lichen-flora of Southern California, — III."

The *Bulletin of the Torrey Botanical Club* for July contains the following articles — Nash, "A preliminary Enumeration of the Grasses of Porto Rico"; True and Gies, "On the Physiological

Action of some of the Heavy Metals in Mixed Solutions"; Rennert, "The Phyllodes of *Oxypolis filiformis*, a swamp Xerophyte"; and, Fink, "Some common Types of Lichen Formations."

The Canadian Record of Science, Volume 9, No. 1, contains a summary of the "Progress of Botany in the 19th Century," by Campbell, and a note by Emberson on the "Trees of Montreal Island."

The *Journal of the New York Botanical Garden* for July contains an account by Professor Underwood of explorations in Jamaica and an account of the Tree-fern house of the New York Garden.

The *Plant World* for July contains the following articles: — Safford, "Extracts from the Note-Book of a Naturalist on the Island of Guam. — VIII "; Barrett, " [Size of flowering Furcræa] "; Waters, "The resting period of Plants "; Schneck, "The Cross-bearing Bignonia or Cross Vine "; George, "The Preservation of Native Plants "; Bailey, "Plants of Universal Application "; Harper, "The Water Hyacinth in Georgia "; and Waters, [Tipularia]."

Rhodora for July contains the following articles: — Fernald, " *Chrysanthemum leucanthemum* and the American White Weed "; Sargent, "Recently Recognized Species of Cratægus in Eastern Canada and New England, — V. "; Robinson, "Preliminary Lists of New England Plants,— XII. [Eriocaulaceæ, Phytolaccaceæ, Aizoaceæ, Portulacaceæ, Caryophyllaceæ, Illecebraceæ and Sarraceniaceæ]"; a short biographical sketch of Henry Griswold Jesup; Flynn, " A second Station for *Cyperus Houghtoni* in Vermont "; and Morss, " *Clematis verticillaris* in the Middlesex Fells."

Torreya, for July, contains the following articles: — Lloyd, "A new and cheap form of Auxanometer"; Nash, "A new Aletris from Florida"; Cowell, "Two new Carludovicas from the island of St. Kitts, W. I. "; Flynn, "Plants new to Vermont, found in Burlington and vicinity "; Britton, "A new Lippia from Porto Rico, and A new Waltheria from the Bahamas"; and Harper, "*Elliottia racemosa* again."

Among the many recent elementary text-books one of the best is Andrews' *Botany all the Year Round*, published by the American Book Company, a well illustrated, well devised and well written book for the secondary schools.

Volumes 2 and 6 of Ascherson and Græbner's *Synopsis der Mitteleuropäischen Flora* are being currently published in parts serially numbered.

An analytical account of the higher groups, families and genera of Mexican plants, by Conzatti, is in course of publication by the Secretaria de Fomento of the City of Mexico, under the title "Los géneros vegetales mexicanos."

A dictionary catalogue, with annotation and illustrations, of the economic plants of Porto Rico, by Cook and Collins, forms Part 2 of the current volume of *Contributions from the United States National Herbarium*.

A brief popular account of "Vegetation in Greenland," with illustrations from herbarium material, is published by W. E. Meehan in *Floral Life* for July.

Part III of Cooke's "Flora of the Presidency of Bombay," completing the first volume, extends through the order Rubiaceæ.

As is customary with the *Proceedings of the Linnean Society of New South Wales*, Part IV of Volume 27, recently issued, contains a number of interesting papers referring to the Flora of Australia.

Volume LXII of the *Natuurkundig Tijdschrift voor Nederlandsch Indië* contains important papers by Koorders on the botany of the Dutch Indies.

The result of evolutionary and physiological investigation of the physiological rôle of mineral nutrients in plants, by Loew, is published as *Bulletin* 45 of the *Bureau of Plant Industry*, U. S. Department of Agriculture.

A summary, by Pond, of MacDougal's Influence of Light and Darkness upon Growth and Development, is separately printed from the *Monthly Weather Review* for April.

An extensive paper by Eberhardt on the respective influence of dry and moist air on the form and structure of plants, is contained in the *Annales des Sciences Naturelles*, Volume 18, Nos. 1–3, of the current series.

The conclusion of Schulz's monograph of the genus Cardamine is contained in Engler's *Botanische Jahrbücher*, Volume 32, Heft 4.

Papers on Rubus and Cratægus, by Ashe, constitute the larger portion of Part I of the current volume of the *Journal of the Elisha Mitchell Scientific Society*.

An Arceuthobium of Tsuga in the Northwest is named *Razou-*

mofskya tsugensis by Rosendahl in *Minnesota Botanical Studies* of July 3, 1903.

A brief economic article on Agaves, by Nelson, is reprinted from the *Yearbook of the Department of Agriculture* for 1902.

Guerin publishes, in the *Journal d'Agriculture Tropicale* of June 30, an interesting account of the oil palms of Guatemala known as Corozos, those of the Atlantic slope referred to *Attalea cohune* and those of the Pacific slope to *Elæis melanocarpa*.

An account of Japanese bamboos and their introduction into America, well illustrated from photographs, is published by Fairchild as *Bulletin 43* of the *Bureau of Plant Industry* of the United States Department of Agriculture.

A morphological and anatomical study of a hybrid of *Agropyrum violaceum* and *Elymus arenarius*, by Gallœ, is published in *Botanisk Tidsskrift*, Volume 25, Heft 2.

No. 19 of Holm's "Studies in the Cyperaceæ," dealing with the genus Carex in Colorado, is published in the *American Journal of Science* for July.

Biographic sketches of Bescherelle, giving a list of his publications, are contained in No. 3–4 of the current volume of *Bulletin de la Société Botanique de France.*

A short biographical sketch of Micheli, with protrait, is published in No. 85 of the *Actes de la Société Helvétique des Sciences Naturelles.*

CORRESPONDENCE.

To the Editor of the American Naturalist :

SIR : At the May meeting, this year, of the Philadelphia Academy of Natural Sciences, Miss Sarah P. Monks read a note on the "Regeneration of the Body of a Starfish." The brevity of the communication and the inconspicuous place given it in the published *Proceedings* of the meeting are not calculated to assure it the attention it deserves.

I quote from the report : "In studying regeneration in *Phataria* (*Linckia*) *fascialis* she had cut arms at different distances from the disk, and a number of the single rays produced new bodies. The free ray made a new body and the rest of the starfish produced a new ray .... In the photograph of a six-rayed Phataria, the cut ray attached to the body shows a small ray sprouting, while the free ray shows four new rays. This was cut July, 1902, and the photograph taken February, 1903."

Miss Monks is to be congratulated on having at last produced the experimental evidence demanded by the skepticism of recent writers on the soundness of Haeckel's conclusion [1] reached long ago that "jeder abgelöste Arm [of certain starfishes] reproducirt die *ganze Scheibe* nebst den übrigen Armen."

I have been permitted by Miss Monks to examine all her specimens bearing upon this subject, and have followed her experiments with much interest and deem it but justice to her to say that in reality she has the data for a considerably fuller presentation of the question than would appear from the meager report which has elicited these comments. It is to be sincerely hoped that a fuller, well illustrated account of her observations may be published before long.

WILLIAM E. RITTER.

University of California,
    Aug. 22, 1903.

[1] Die Kometenform der Seesterne und der Generationswechsel der Echinodermen. *Zeitsch. wiss. zool.*, Bd. 30, 1878, p. 424.